APPENDIX B: GAS R&D PROJECT CONCEPT ABSTRACT SUBMITTALS

All of the 172 abstracts that were submitted can also be found at the Energy Commission's website:

www.energy.ca.gov/naturalgas_research/documents/

Abstracts are presented in ascending order of identification numbers.

Project Concept #1: Conversion to Genuine Alternative Energy

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Description

Successfully solicit an entire community,college or similarly large energy user.Collectively develo,design and install alternative systems to provide all the heating,cooling and hot water.Cooperate with California Energy Commission's staff and significantly dredentialed experts from State,Federal and related Agencies and groups to absolutely verifiy the legitimacy and reliable performance to inevitably replace any relinace on fossil fuels.

Benefits

Reduce or eliminate the every expanding brown outs and inefficient high summer and winter power loads.Less generation necessity , less airborne pollutants,less costs to everyone.

Responsiveness to CEC Goals

The General Public deserves a minimum reduction of energy costs and we are quite capable of providing even in massive scale.tHE TAXES PAID BY THE GENERAL PUBLIC underwrite blatant and ridiculous profits by the energy community.This evercise/Project will validate the option.
and reduce costs nationally across the board.

Objectives

Irrefutable Proof of the legitimate role of alternative systems in any context.

Budget

2005 : 1000000
2006 : 5000000
Other : 10,000,000
(10 years)

Comments

All of the invested/granted funds would be reimbursed from revenues derived from alternative energy payments while maintaining a twenty five percent reduction per customer per month for a minim of ten years with NO adverse effect from ongoing market fluct

Project Concept #2: Hybrid systems for opportunities in natural gas savings in industry

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Description

Natural gas is used primarily for combustion and for feedstock in the production of numerous industrial chemicals. Processes used in both applications are typically stand alone systems designed to maximize the efficiency and produce reliable and low cost energy conversion. Although most industrail process equipment, whether boilers, engines, process furnaces, or reformers have achieved a much needed improvements in efficiencies because of recen rise in energy costs, opportunites exists to achieve further reductions in natural gas use via implementation of hybrid technologies that avail themselves of synergies between processes to produce improvements in plant-wide fuel efficiencies and reduced operating costs. This project is aimed at identifying and quantifying the potential for application of hybrid technologies that can combine the generation of electricity within the fence with the production of heat or mechanical power or industrial chemicals. Whether is the application of topping or bottoming CHP cycles or the cogeneration of compressed air, space heating, industrial drying, or VOC destruction, this project will provide specific details of industrial processes that can be linked to reduce the combined amount of natural gas used, thus providing a net improvement in fuel efficiency. The project will evaluate all the major SIC code industries in California.

Benefits

Hybrid technologies, like CHP, have the ability to reduce fuel consumption by 10 to 30 percent with the same level of energy and product delivery. Currently, every industrial process equipment that operates independently can be made to be a thermal sink for a distributed power unit. Therefore, estimates of fuel savings can be on average 10-30% of current fuel consumption. More realistically, becasue of investment costs and duty cycles, perhaps only about 50% of the opportunities may result in savings. Thus, one expects overall savings potential to be 5-15% of the State's use of natural gas in industry

Responsiveness to CEC Goals

Improves competitiveness of industries by lowering their fuel use and costs
Reduces the State's dependence on imported surces of natural gas
Lower the levels of associated CO2 emissions with net benefits on global warming
Promotes development of new industrial processes increasing employment in the State

Objectives

Detailed list of industrial processes that are considered opportunities for application of hybrid technologies including CHP and others as described above.
Detailed list of which specific hybrid technologies that are most applicable
Quantifiable levels of fuel savings per application and hybrid systems
Development and demonstration needs to validate performance
Research needed in process controls and system safety including adherence with standards and codes
Estimates of costs and cost benefit analyses
List of recommendations for educational programs to improve acceptance of hybrid technologies

Budget

2005 : 1000000
2006 : 500000
Other : 1500000

Comments

Project Concept #3: Maximizing efficiency of current Rankine cycle utility plants

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Description

Old natural gas-fired Ranking plants used in the generation of electricity in California represent a grossly inefficient way of generating power. Becasue these utility plants represent paid assets, even their wasteful way of using natural gas for power generation are not sufficient economic deterrent for utilities. FUrthermore, California has a small reserve excess capacity of power generation so that these less efficient plants are needed to maintain adequate levels of power generation in the State. However, their use continues to be a wasteful way of using precious quantities of premium natural gas to generate electricity. Therefore, this project focuses on evaluating the potnetial for repowering these older plants so to boost efficiency while presenrving the asset values for the utilities. Many older power plants can be repowered using topping cycles with application of gas turbines exhausting into gas-fired utility boilers. The incremental power generation of the repowering project would produce a net reduction in fuel use per kWh produced thus lowering the heat rate of the plant. Therefore, this study aims at evaluating the repowering potential of the exsting gas-fired utility boiler population. The evaluation will address the technical feasibility, the scope, the age, the cost, the heat rate improvement, the emission reductions, and added asset value that would result from each repowering project

Benefits

Improved heat rates of power plants

Lower CO2 emissions

Lower NOx emissions. It is estimated that the NOx reduction could be on th eorget of 30-50 percent from current power plant levels. This requirements

Lower cost of NOx compliance for exisiting plants.

Responsiveness to CEC Goals

Project will result in significant savings in gas consumption with reduced air pollution. It will aslo lower the cost of emission cmplaince since many repowering project can be synergistically better that advanced NOx emission controls needed for further reductions in emissions from current power plant levels.

Objectives

A detailed assessment of the economic benefit of repowering old plants and associated fuel savings for the state, bringing the State's fleet of power generators to an overall State-wide heat rate that wil result in significant savings in gas use and promote the State as the most efficient generator of electricity. The repowering also represents a significant investment for the State resulting in economic growth and will identify plants that have insfficient net asset value to remain in operation in the State, thus further reducing the wasteful use of natural gas. Becasue California is principally a natural gas-based power producer, the improvement in overall heat rate of the overall mix of plants will provide great benefits.

Budget

2005 : 2500000
2006 : 1000000
Other : 3500000

Comments

Project Concept #4: Modeling and Control of Distributed Energy Systems

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Description

For several years, growing power demands have strained power transfers from the Northwest through the web of transmission lines in West to the load centers of Los Angeles and Southern California. The complexity and magnitude of the power flows overwhelm operators resulting in the black outs of 2001. It should be accepted that from time to time a few sensors will fail and the operators can not recognize the impending break down of the system and orderly control asynchronous operation in absence of distributed generation. However, a distributed energy system can provide adequate safe guard for a major load center such as Los Angeles to develop methodology how the system should be separated in asynchronous operation of smaller regions. This proposal addresses the design and control of distributed generation systems.

This proposal is a collaborative effort EPRI PEAC Corporation, The Ohio State University (OSU), and Polytechnic University, Brooklyn (PUB), to design, model and control fuel cells in distributed energy systems. The Research team will perform the following: 1. Develop models for fuel cells and power converters for a parallel grid-connected operation. 2. Study the stability of the system and development of advanced distributed/decentralized control systems. 3. Develop an experimental test beds to evaluate load-sharing algorithms for parallel PWM inverter operation, including the harmonic current sharing and free-running operation issues. 4. Develop a virtual test bed consisting of two experimental fuel cells operating with large scale simulation models of fuel cell systems for large scale systems studies 5.Develop a course on modeling and control of fuel cells for distributed energy systems in modular structure and organize workshops and establish a web site for national dissemination.

Benefits

Fuel cells powered with natural gas can be a clean, reliable source of energy. By the use of distributed generation, the estimated 10% loss in the electrical transmission and distribution system can be greatly reduced, as electrical distribution is replaced by lower-loss gas distribution. Fuel cells produce no pollution, which would greatly reduce the environmental impace of electrical power generation. The proposed research would optimize operation and control of fuel cells in distributed power networks, improving system stability and power factor, increasing the reliability and efficiency of the electrical power grid. The research will identify means to reduce the total harmonic distortion (THD), which will also reduce energy losses. Load sharing will allow multiple fuel cells to be paralleled as necessary for greater load carrying capability.

Responsiveness to CEC Goals

1. Advances in modeling and control will improve efficiency of fuel cells operation in a power grid. In particular, power factor can be improved as AC/AC power converters function in an active manner for better power quality and the above problems should be overcome by a good control technique to assure expansion of the DES around the world.
2. The research team will integrate power systems, power electronics and, control technology to model and control fuel cell based energy systems. Thus, new vistas for pedagogical opportunities are made possible by recasting abstract concepts and allied problems in various frameworks such as optimization modeling and estimation, control and digital signal processors. Furthermore, this proposal will address the critical need for simulation and experimental test beds to expand the knowledge base in energy systems by training new generation of students in these basic disciplines by developing state of the art technology in modeling and control of distributed generation and fuel cell energy systems.
3. Action V. of the California Energy Action Plan is addressed by this proposal, in part5icular, items 1 and
4. Opportunities for involvement of California entities will be open to EPRI PEAC's parent company, EPRI of Palo Alto, CA. In addition, the participation of a major California research university will be sought.

Objectives

In this proposal, the modeling, stability analysis and control of power converters operating in parallel mode and DES will be investigated. The stability studies of distributed energy systems proposed in this proposal is crucial for secure/reliable operation of these systems. The first objective of this research is a conceptual study of different unconventional power systems and understanding the fundamental issues faced in these systems. Current status, future trends, and role of power electronics will be explored. As a result of this preliminary investigation, a proper definition of stability of DES will be established. In addition, a representative system will be designed to be considered for further studies. In our studies, two topologies will be investigated: one is a grid interconnection in parallel with two fuel cell systems and the other is a multiple operations for redundancy with a grid interconnection. Each topology includes many research issues that should be solved because it is combined with several applications of DES, so it will be executed step by step for ease of combination according to different applications.

Budget

2005 : 1000000
2006 : 1000000
Other : 2000000

Comments

The DES can be used to feed power back to the utility mains (grid interconnection) or to directly supply electric power to loads (a standalone AC system). Especially, when there is a disturbance in the grid system, the system operator may request the dis

Project Concept #5: Electric power production based on pulsed detonation of natural gas

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Description

A pulsed detonation process can be shown to be theoretically more efficient than the usual deflagration process used in electric power production, namely the burning of fuels. In addition to efficiency, other advantages include potentially lower manufacturing and maintenance costs, and scalability. However, detonations are, in fact, difficult to achieve in a short distance as well as repetitively to make detonation devices practical. Only recently have efforts been successful that there is interest in developing pulse detonation propulsion systems. The same basic principles for propulsion systems can be applied to developing electric power production devices although no such discussion can be found in the literature, except for our own patent pending.

The concept's goals are (1) to demonstrate the feasibility of detonating natural gas and air mixtures in pipes within a reasonable distance of less than one meter through the use of detonation enhancement techniques, (2) to develop a detonation-based demonstrator that can produce electricity, and (3) to quantify the improvements in terms of efficiency, and manufacturing and life cycle cost.

Benefits

The potential benefit to the public is enormous if such a device is proved feasible. For example, the scalability feature enables small devices to be built as emergency power sources to larger units for distributed production.

Benefits -- higher energy efficiency than existing processes, lower manufacturing cost, lower life-cycle cost, reduced emissions, scalability

Responsiveness to CEC Goals

The project concept requires high risk, long-term basic research. Various principles involved in ensuring that detonation can occur in a short distance have not converged at the moment. Other than basic science, there is also no known practical, low-cost concept for harnessing detonations for electric power production. The problems of component heating and fatigue, noise, power extraction, and optimum design of components have not been addressed.

The lack of familiarity in the scientific and power producing communities of the potential of pulsed detonation means that such a proposal will likely be met with skepticism even if it satisfies all known scientific principles. It is therefore difficult for commercial enterprises to be committed to underwriting such a concept, especially at its nascent stage.

Objectives

1. Demonstrate the feasibility of detonating natural gas and air mixtures in pipes within a reasonable distance of less than one meter through the use of detonation enhancement techniques
2. Develop a detonation-based demonstrator that can produce electricity

Budget

2005 : 250000 2006 : 250000 Other : 500000

Comments

The device is versatile enough to use other gaseous hydrocarbons, such as methane and propane

Project Concept #6: Increasing Distributed Generation Efficiency Using Waste Heat Sources

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Description

Waste heat is a ubiquitous energy source; it's found everywhere in California from process plants to manufacturing plants to thermal oxidizers to surplus vented steam to engine exhaust stacks in industries ranging from food and kindred, pharmaceuticals, cement, chemicals, refineries, etc. Most, if not all, are natural gas-fired.

Converting low grade heat to power efficiently, economically and reliably can improve the energy efficiency of industrial processes and reduce CO2 emissions simutaneously. Currently, due to lack of awareness, poor economics of steam systems in small sizes and the users' aversion to any technical risk, heat recovery power systems are virtually non-existant in California for non-utility generation.

The proposed solution to this problem is a non-steam based power system that can provide baseload generation with better thermal efficiency in small sizes than steam systems and can operate automatically and remotely to reduce O&M costs. Estimated all-in generation cost for this new system is $30-40/MWh.

In sizes from 500kW to 5000kW these power systems can be used 'inside the fence' for distributed applications. In addition to displacing retail power purchased from the utility these systems offer the user better security; power can be produced from these sources continuously so 24/7 processes are not forced to shut down during grid interruptions.

An absorption refrigeration system has been modified to provide power as well as refrigeration using low grade heat. It is called an absorption power cycle (APC). It contains all the same equipment as an absorption chiller plus a turbine generator set. There are no material or component development issues.

The APC is able to convert waste/surplus heat to economic power from low source temperatures;

- gas: 350F
- liquid: 200F
- steam: 212F

Besides its improved thermal efficiency the APC contains smaller heat exchangers by its proprietary high transfer rate, further reducing plant cost.

A successful demonstration of the APC will establish the technology as an effective means by which the use of natural gas is made more efficient and cleaner (displace CO2)throughout California. Further, its widespread use will displace central station power generation one-for-one and provide additional energy security to the end user.

Benefits

According to the US EIA the amount of natural gas consumed in California in 1999 (the latest year data are available)was 1196.3 trillion Btu/yr.

Using an average conversion efficiency of 17% (for all source temperature levels)and assuming 10% market penetration, the amount of generation in California from conversion of gas-fired waste heat to power is 680MW. Considering industrial gas useage growth in California since 1999 this output is now to closer to 800MW.

The amount of CO2 displaced by this amount of fuel-free generation is estimated to be 800,000 tonnes/yr

Responsiveness to CEC Goals

The proposed project is clearly in the public interest by virtue of its goals to improve the efficiency of gas-fired processes and, in so doing, lower the energy costs of industrial plant users throughout the state and reduce CO2 emissions as it displaces fossil-fired central station generation.

Improving efficiency, reducing generation cost, increasing energy security and lower emissions are all consistent with California State Energy policy.

Widespread use of the APC technology within California will reduce energy costs of industrial users which, in turn, will reduce the cost of goods manufactured and provide a commensurate savings to the California consumer. The general public will also benefit from the reduced CO2 emissions, lower requirement to build central station plants and additional energy security (less likelihood of blackouts from excess demand in summer).

The proposed project will be highly visible within Energy Concepts. Accordingly, EC expects to provide considerable cost share from commercialization partners and its own sources.

Objectives

The primary purpose of the project is demonstrate the improved thermal performance of the APC and its ability to operate in a safe, reliable manner, unattended, in a baseload, commercial or industrial setting.

Confirmation of the APC's performance (operational data and O&M entries) over a year or two of operation will:

1. Substantially mitigate the technical risk issue and make the technology more 'bankable' for future projects, some of which may be financed in a lease or BOT agreement.

2. Provide data to the CEC who, among others in the energy R&D community, are likely to distribute the results of the project to industries and non-utility generators within California.

3. Permit the APC sponsor (Energy Concepts Co) to seek strategic partners and to disseminate the results in trade journals and conferences to accelerate commercial development.

4. Use the 'as built' drawings and specifications to develop a standard configuration/bill of material that will reduce all non-recurring costs and corresponding capacity cost (CAPEX) of subsequent plants. Likewise, the operational data and O&M experiences will be used to develop operating manuals to further 'standardize' the APC and lower its O&M costs.

Budget

2005 : 1500000
2006 : 2500000
Other :

Comments

Project Concept #7: Dual Function Absorption Cycle

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Description

Gas turbines in the 5 - 50MW class are popular in California and are used mostly for Industrial applications. Many of these are aero derivatives and operate as simple cycle, i.e., they do not have any type of heat recovery.

During summer operation these gas turbines lose much of their power and efficiency due to high ambient temperature. In some cases the user will install some kind of chiller or water injection to cool the gas turbine inlet in an attempt to regain power and efficiency.

An absorption refrigeration cycle has been modified by Energy Concepts Co to operate as a power cycle as well by adding a turbine generator set to the existing chiller design. The result is a dual function absorption cycle (DFAC) that provides power and refrigeration from the same facility, using only low grade waste heat as the energy source for the DFAC.

The DFAC is an ideal solution for gas turbines in the 5-50MW class that operate a substantial portion of the year at high ambient temperature. About 25% of the gas turbine exhaust is used to reduce the inlet temperature by ~40F, thus adding ~20% to the GT output compared to what it produces at summer ambient. Simultaneously, the remaining 75% of the GT exhaust heat is used in the absorption bottomong cycle to provide additional power. This adds another 20-25% to the system output.

The DFAC yields:

1. Additional system output via inlet chilling and bottoming cycle simultaneously,
2. Improved heat rate
3. Low CAPEX due to economy of scale, high conversion efficiency of the absorption power cycle and high transfer rates in the heat exchangers (smaller units).

It is suggested that a co-funded demonstration of the DFAC be completed as part of this initiative to improve the efficiency and economics of natural gas-fired systems in California.

Benefits

The efficiency of simple cycle gas turbines can be improved by 25% during most of the year (nine months) and the summer operation efficiency can be improved by 40-50%. Also, the added capacity provided during summer operation will reduce the need for additional utility peaking plants.

Responsiveness to CEC Goals

The commercial development of the DFAC for gas turbine installations will improve operational efficiency, reduce fuel consumption, reduce CO2 emissions and improve energy security within California by developing better distributed generation techniques that can operate during grid interruptions and, in the aggregate, will mitigate the need for additional central station generation within California.

Lowering the cost of generation and reducing emissions are both in the best interest of the public, as well the development of efficient distributed generation over central station utility plants.

Objectives

It is important that the proposed project be able to demonstrate the improved performance features of the DFAC, its robust reliability and unmanned operating capability. Data needs to be acquired over a period of a year or two to confirm the long term behavior of the plant (availability and reliability) and to assess the O&M cost.

Using as built drawings and equipment specifications an estimate of CAPEX for future installations can be determined.

Budget

2005 : 1500000

2006 : 2500000
Other :

Comments

Project Concept #8: Gas energy conservation, laundries

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Description

• Project problem: Laundry drying systems are inefficient.

Main contributor to the laundry efficiency problem is the clothes dryer. This program addresses & mitigates the inefficiency problems of clothes dryer systems in commercial, coin operated, laundries.

Benefits

• Benefits provided: SmartDry provides the following

1) Improved laundry drying process efficiency (Also, reducing air pollution)

2) Cleaner laundry (user benefit)

3) Reduced drying time (thus pleasing customers & improving laundry thru put rates). It should be noted that after the laundry proprietor passes the new equipment "break even point," the proprietor can reduce drying prices (user benefit)

4) Increased laundry proprietor's profits (result of cost reduction)

5) Automated operation (including precision humidity control, diagnostic testing & power consumption tracking reports) (system is a turn key operation).

6) Redesign of future typical laundry facility (many dryer features can be removed when used in the SmartDry environment)

7) Update financial data

Responsiveness to CEC Goals

1) Reduced natural gas consumption

2) Laundromat customer / public benefits - reduced laundry processing time & future reduced laundry batch drying costs

3) Reduced air pollution (50% reduction)

4) Creation of many manufacturing & installation jobs

5) Automated operation

Objectives

Laundromat owners will see lower Gas bills and laundromat customers will enjoy cleaner laundy, shorter times in the laundry, and lower costs.

Budget

2005 : 315,000
9 mo
2006 : 0
Other : TBD

Comments

Updates to the SmartDry technical data package for the full scale production effort (drawing updates & tooling) will be covered in the Full scale production effort - Phase 3 section - TBD

•Considering providing government incentives (taxes & subsidies),

Project Concept #9: Small scale plant for producing clean renewable methane

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Description

The goal of the project is to carefully evaluate technologies for producing renewable methane from biogas, then select the most cost effective one and build a small scale prototype plant.

Natural gas as normally understood is a fossil fuel, but this understanding is too narrow. Natural gas also include biogas, digester gas, and landfill gas, similar products each of which is 50-70% methane; and renewable methane which is pipeline quality natural gas produced from biogas, digester gas, or landfill gas.

Biogas is created by the action of methanogenic bacteria on organic waste products. This biogas can be combusted to produce electricity or heat, thereby replacing the use of a fossil fuel. It can also be sweetened to remove H2S, moisture, CO2 and other impurities. The end product is biomethane or renewable methane, fully equivalent to pipeline quality natural gas. It can be placed in the natural gas pipeline or used for a vehicle fuel in fleet applications.

There are at least five technologies for sweetening biogas: water scrubbing, pressure swing adsorption, glycol, membrane, and chemical absorbtion using an amine. The project will study these technologies to decide which is the most cost effective, most reliable, and most environmentally beneficial on a small scale. Using the best technology, the project will build a prototype to produce clean renewable methane from organic material such as animal manure, food processing waste, slaughterhouse waste, landfill gas or other similar sources.

Benefits

Developing technologies to produce clean renewable methane on a small scale have a number of environmental and economic benefits. Renewable methane does not increase greenhouse gas emissions. In many cases it reduces greenhouse gas emissions because it captures methane containing biogas or landfill gas that would otherwise be released into the environment and turns it into renewable methane. As renewable methane it is combusted, thereby destroying methane that would have otherwise entered the atmosphere.

Renewable methane replaces the use of fossil fuel, thereby increasing energy security and reducing the need for imported energy. Renewable methane plants bring economic benefits to California by creating methane in-state instead of importing it. Small scale cost effective technologies to produce clean renewable methane can also be used to process sour gas found in stranded natural gas wells, thereby taking a wasted resource that emits greenhouse gas forming methane and turning it into a resource

Responsiveness to CEC Goals

This project is focused on one of the few renewable technologies that produces pipeline quality natural gas. It supports the State energy policy by reducing dependence on fossil fuels, and reducing greenhouse gas emissions. By developing an in-state energy resource it supports the local California economy. No private company or investor owned utility has shown an interest in developing this technology. The Federal government has shown much interest in funding anaerobic digesters that produce biogas as evidenced by the most recent awards under Farm Bill Section 9006 Renewable Energy grants that funded 37 anaerobic digesters on farms.

Objectives

The most important objectives are to reduce greenhouse gas emissions, to increase the supply of natural gas, and to reduce dependence on imported fossil fuel energy.

Budget

2005 : 600000
2006 : 1200000
Other :

Comments

Project Concept #10: Centralized plant to produce biogas from multiple waste streams

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Description

The goal of the project is to research technologies, then select the most cost effective one and build a centralized anaerobic digester that will accept feedstocks from a range of waste material such as animal manure, food processing waste, slaughterhouse waste, green waste, household organic waste, and other similar sources.

Natural gas as normally understood is a fossil fuel, but this understanding is too narrow. Natural gas also includes biogas, digester gas, and landfill gas, similar products each of which is 50-70% methane. Biogas is created by the action of methanogenic bacteria on organic waste products. This biogas can be combusted to produce electricity or heat, thereby replacing the use of a fossil fuel. It can also be sweetened to remove H2S, moisture, CO2 and other impurities. The end product is biomethane or renewable methane, fully equivalent to pipeline quality natural gas. It can be placed in the natural gas pipeline or used for a vehicle fuel in fleet applications.

In Europe there are about two thousand centralized plants that process a variety of organic wastes to produce biogas. They are usually located at publicly owned treatment works. Each plant has a fairly stable recipe depending on its local range of feedstocks, and is optimized for that recipe. To the best of our knowledge there are no such plants in the U.S. This project will research the technologies used to process a mixed waste stream, locate a site, and build a centralized plant at a publicly owned treatment works or a landfill, processing a mixed waste stream appropriate to that location as a proof of concept.

Benefits

There are a number of environmental and economic benefits that derive from developing technologies to produce biogas from multiple organic waste streams. Biogas does not increase greenhouse gas emissions. In many cases it reduces greenhouse gas emissions because it captures methane containing biogas or landfill gas that would otherwise be released into the environment and turns it into an energy resource. As biogas or renewable methane it is combusted, thereby destroying methane that would have otherwise entered the atmosphere.

Biogas replaces the use of fossil fuel, thereby increasing energy security and reducing the need for imported energy. Biogas plants bring economic benefits to California by creating methane in-state instead of importing it. The diversion of organic material can extend the life of landfills.

Responsiveness to CEC Goals

This project is focused on one of the few renewable technologies that produces a natural gas. It supports the State energy policy by reducing dependence on fossil fuels, and reducing greenhouse gas emissions. By developing an in-state energy resource it supports the local California economy. No private company or investor owned utility has shown an interest in developing this technology. The Federal government has shown much interest in funding anaerobic digesters that produce biogas as evidenced by the most recent awards under Farm Bill Section 9006 Renewable Energy grants that funded 37 anaerobic digesters on farms.

Objectives

The most important objectives are to reduce greenhouse gas emissions, to increase the supply of natural gas, to reduce dependence on imported fossil fuel energy, and to divert material from landfills.

Budget

2005 : 600000
2006 : 1100000
Other :

Comments

Project Concept #11: Small ultra low NOx biogas engine

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Description

The goal of the project is to research and develop an engine with a nameplate no higher than 100 kW that will generate electricity by combusting biogas from animal waste while generating no more NOx than a central station power plant.

Natural gas as normally understood is a fossil fuel, but this understanding is too narrow. Natural gas also includes biogas, which is 50-70% methane. Biogas is created by the action of methanogenic bacteria on organic waste products. This biogas can be combusted to produce electricity or heat, thereby replacing the use of a fossil fuel.

Currently eight California dairies have installed anaerobic digesters that produce biogas and use it to generate electricity. Four more are under construction, and three more are funded but have not begun construction. Both the San Joaquin and South Coast Air Districts are proposing that large dairies be required to construct anaerobic digesters to process their manure. These digesters reduce greenhouse gas emissions, provide a renewable fuel, reduce VOC emissions, and support the local rural economy in California.

A major problem with the digester engines is that the combustion of dairy biogas produces NOx. Catalytic converters break down within weeks due to the impurities in the biogas. Gas turbines get corroded within a year or two. Larger scale operations can install lean burn engines that bring NOx emissions down to 50 ppm, but this still far exceeds central station emissions. Air districts may not permit engines that exceed 50 ppm, and may not even accept that level in the future.

The proliferation of this environmentally beneficial technology will be limited by the NOx problem. This project will develop a robust small engine that will combust biogas while not producing NOx.

Benefits

There are a number of environmental and economic benefits that derive from reducing NOx emissions from biogas combustion for electrical generation. Reduced NOx emissions produces cleaner air. Reduced emissions will encourage the development of more dairy based anaerobic digesters.

Biogas does not increase greenhouse gas emissions. In many cases it reduces greenhouse gas emissions because it captures methane containing biogas or landfill gas that would otherwise be released into the environment and turns it into an energy resource. As biogas or renewable methane it is combusted, thereby destroying methane that would have otherwise entered the atmosphere.

Biogas replaces the use of fossil fuel, thereby increasing energy security and reducing the need for imported energy. Biogas plants bring economic benefits to California by creating methane in-state instead of importing it.

Responsiveness to CEC Goals

This project is focused on eliminating the one environmental problem associated with one of the few renewable technologies that produces a natural gas. The reduction of NOx from dairy digesters improves air quality in two non-attainment air districts, San Joaquin and South Coast. It supports the State energy policy by reducing dependence on fossil fuels, and reducing greenhouse gas emissions. By helping to develop an in-state energy resource it supports the local California economy. The Federal government has shown much interest in funding anaerobic digesters that produce biogas as evidenced by the most recent awards under Farm Bill Section 9006 Renewable Energy grants that funded 37 anaerobic digesters on farms.

Objectives

The most important objective is to reduce NOx emissions. By doing so, anaerobic digestion of dairy waste can proliferate thereby increasing the supply of natural gas, reducing dependence on imported fossil fuel energy, and increasing the viability of the dairy industry.

Budget

2005 : 400000
2006 : 400000
Other :

Comments

Project Concept #12: A Novel Process Technology for Conversion of Natural Gas to Fuels

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Description

A new process chemistry concept has been developed by the University of California Santa Barbara (UCSB) and GRT, Inc. for the efficient conversion of natural gas to transportable, clean burning, liquid fuels. The proposed project will demonstrate the technology in a 1 gallon/day reactor which will be used to generate interest from California-based fuel producers to adopt the process. With an enormous and increasing need for reasonably priced liquid transportation fuels necessary for economic prosperity balanced by a commitment to improved air quality, the need for California-based Clean Fuel technology is important. The new process we would like to develop with funds from the PINGP is a general platform for coupling the natural gas alkanes (methane, ethane, propane, and butane) together to produce high octane fuels and additives without the contaminants present in oil-derived fuels. The novelty of the approach is in the integrated use of bromine-activated alkanes with a regenerable solid-phase cataloreactant, which allows complete recovery and reuse of all bromine (U.S. Patent # 6,462,243). The use of the cataloreactant in a specifically designed "zone reactor" (U.S. Patent # 6,525,230) offers the potential for significant process cost advantages and safety over conventional natural gas conversion technologies (e.g. Fisher-Tropsch). We have quantitatively demonstrated the technology on a laboratory scale, for the controlled conversion of natural gas alkanes to a variety of oxygenates (methanol and ethanol), olefins, and gasoline with yields expected to be well above those of the current commercial processes. Unlike conventional natural gas conversion, the process operates at relatively low temperatures and pressures and produces products directly. The simplicity of the process makes possible the use of small gas sources including stranded natural gas, biogas, and coal bed methane. The process technology has particular applicability in California, however, its full potential may impact the entire U.S. and world.

Benefits

In addition to the benefits to the public described in above, there are broader benefits to all citizens if the process technology is successful. Oil will inevitably be exhausted and worldwide production will diminish in the near future - the price of oil will remain high and move higher. Natural gas will remain abundant and less expensive worldwide for at least an additional 50 years. A technology that can cheaply and efficiently convert natural gas into clean burning (sulfur free) liquid fuel will help provide an essential resource to the public into the future. Further, the same process technology used for gasoline can also synthesize alcohols and dimethylether (DME) considered by some to be attractive fuel alternatives. DME can be made using the same technology and is a direct replacement for diesel fuel that is significantly cleaner burning and has a higher cetane number than conventional diesel. These fuel alternatives made from natural gas are better for California than the alternative which is the direct use of natural gas as LNG which is dangerous and costly. California will be the site of increasing importation of LNG, any cost effective technology that can process natural gas prior to importation into a safer, transportable fuel will benefit California.

Responsiveness to CEC Goals

Short term success will provide California with Clean Fuels. Long term success (national, world-wide deployment) will provide financial returns for California through tax revenue, jobs, royalties and dividends (to the University of California, a shareholder).

The competitive or regulated entities that provide fuel to California rarely fund technology at this early stage. While large scale plants will involve such entities, the basic R+D must be proven with help from PINGP.

Other criteria in D. 04-08-010 and State Energy Policy are encompassed by program goals:

- UCSB-GRT process provides efficient production of Clean Fuels with less carbon dioxide production than existing processes.
- The process can be extended to methane from waste and landfills (renewables). UC-GRT process offers a reasonable probability of providing benefits to the general public; the concept has been shown to work in the laboratory with the results scrutinized in the scientific literature.
- Remaining uncertainty exists in scale-up performance and economics; the purpose of the proposed R+D.
- The funds requested from the PINGP will be matched by GRT. Following two years of support, funding will be obtained through commercialization by California-based entities.

Objectives

GRT is seeking support from the State of California for an accelerated 2 year program to specifically develop the process for Clean Fuel additives and gasoline from natural gas. In year 1 we will design and construct a lab scale-up (~1 gallon/day) demonstration packed bed zone reactor and optimize the supported solids for use as the regenerable cataloreactant. In year 2 we will operate, optimize, and study the reactor system to validate the feasibility and identify major design issues necessary for a commercial demonstration plant (~ 1000 barrels/day) to be pursued in collaboration with a major U.S. fuels company operating in California. Specific issues to be addressed will be; i) a complete understanding of how the zone reactor concept can significantly reduce the capital cost of natural gas conversion, ii) a complete characterization of the process chemistry defining all major and minor products, and iii) coupling of the measured reactor performance to engineering process economic models. During the two year project period a relationship will also be established with one or more California fuels producer(s) to collaborate on making the process available on a large scale to the California public.

Budget

2005 : 250000
2006 : 175000
Other : 425000

Comments

The budget for 2005 will cover the design and construction of a lab scale-up (~1 gallon/day) demonstration packed bed zone reactor the funds requested for the first year from the State of California total $250,000 which represents approximately half of th

Project Concept #13: Advanced Natural Gas Engines & Fuel Systems

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Description

The proposed project would conduct RD&D with medium- and heavy-duty truck manufacturers, the US DOE's National Renewable Energy Laboratory, Clean Energy Fuels, Inc., and Southern California Gas Company to develop advanced engine components, fuel and emission control systems needed to achieve US EPA's 2010 emission requirements. Under NREL's Next Generation Natural Gas Vehicle Project, these technologies would be integrated into commercial truck chassis to meet California's high-use fleet requirements by 2007.

Benefits

PIGR funding would be matched by DOE and manufactures. This funding would enable manufacturers to allocate resources to engineer natural gas components/systems, test and certify emissions, and integrate engines into specific chassis.

The early-compliant NGVs would reduce California's petroleum fuel dependence, and improve local and regional air quality. These benefits would help stimulate economic growth, new jobs, and improve the health and quality of life of California's citizens.

Responsiveness to CEC Goals

The competitive market is concentrating its resources on diesel technology RD&D. Ford and GM discontinued their cutaway NGV products this year. The proposed RD&D is not being pursued at this time.

Regulated low emission vehicle RD&D conducted by investor-owned utilities excludes this engine and fuel system RD&D. PG&E and SoCal Gas will support testing and field demonstrations with customer fleets or their fleets.

Objectives

Complete two medium-duty, one Ford; one GM cutaway, and one heavy-duty, Caterpillar 13 liter, fully integrated natural gas vehicles capable of meeting EPA's 2010 emission requirements, 0.2 g/bhp/hr NOx and 0.01 g/bhp/hr PM limits, at costs competitive with their petroleum fuel conterparts.

Engines developed will be CARB and EPA certified.

Budget

2005 : 2000000
2006 : 2000000
Other : 1000000

Comments

NREL's NGNGV project has helped advance NGV engines and aftertreatment technology and achieved NOx emission targets well below 1.0 g/bhp/hr and particulate emissions below 0.04 g/bhp/hr. The proposed work would compliment NREL's activities, and minimize

Project Concept #14: Natural Gas Pressure Drop at Businesses to Generate Electricity

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Description

The proposal includes the installation of one of PowerVerde's Patented Gas Pressure Motors at an appropriate site where the main line pressure of the natural gas must be reduced to be used in a business or other activity. The installation will demonstrate the the motor is completely sealed, with no leakage of gas, and that the motor will generate up to 100 kW of electricity using 220 cu/ft/min of gas at 150 psi.

The motor installation will involve a 2" pipe inlet with a 3" pipe outlet, said outlet connected to the inlet of the business or other activity which will lower the psi of the inlet by 150psi. The delta P is 150 psi so if the inlet pressure is 300 psi the outlet pressure is 150 psi.

The patented motor is compact, only 24" in diameter and 18" deep. The motor has been tested on a CO2 well-head and other pressure sources. It has been demonstrated that no leakage occures and that the unit will be totally explosive proof.

Benefits

There is no invironmental impact of this type of installation. The electricity generated is the result of using the pressure drop required by most customers, but at the same time delivering the natural gas product to the customer in a reduced pressure form.

Responsiveness to CEC Goals

The production of electricity by this project will demonstrate that it is possible to generate large amounts of electricity without burning any fossil fuel, and at the same time, maintaining that fossil fuel for other purposes

Objectives

This project will domonstrate that it is possible to use the excess pressure in a natural gas pipeline, when it is delivered to a customer that requires a drop in pressure that is normally accomplished by a pressure regulator. In most applications, the customer will be able to generate all of their electical needs and still have use of the natural gas product.

Budget

2005 : 400000
2006 :
Other :

Comments

Project Concept #15: Modeling the Formation and Distribution of Oceanic Methane Hydrates

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Description

Natural gas hydrate is a solid composed of water and natural gas (principally methane) that occurs worldwide in oceanic sediments (and to a much smaller extent in permafrost), and could constitute an important future gas resource. Recent exploratory drilling in the Nankai Trough (Japan) has confirmed the presence of sea-bottom formations containing gas hydrates at high saturations. The occurrence of gas hydrates in oceanic sediments is controlled by the rate of sedimentation, the organic carbon content of the sediments, their grain size and interstitial porosity, fluid pressure, and temperature.

To help understand hydrate formation, during the past two years we have developed a prototype one-dimensional (1-D) time-dependent computer model that describes the histories of seafloor sediments over very long time-scales. It incorporates sedimentation, flow of liquids and gases through the porous sediments, conductive and convective heat transfer, and the natural formation and dissociation of solid methane hydrates. The proposed research will use this model to investigate fundamental phenomenology associated with hydrate formation, and will also extend the model to three dimensions (3-D).

The 3-D computer model will then be initially applied to study the hydrate distribution at Blake Ridge (offshore South Carolina), the Gulf of Mexico, Cascadia (offshore Oregon), and the Nankai Trough. Comparison of theoretical results with field observations from these sites will be used to refine and validate the computer model. A calibrated computer model should prove invaluable for characterizing this potentially enormous gas resource. The computer model should also be useful for investigating the environmental consequences (e.g. seafloor stability) of hydrate dissociation.

Scientific aspects of the ChevronTexaco GOM hydrate program are being managed by scientists from the Scripps Institution of Oceanography in La Jolla, California. Opportunities exist for collaboration with hydrate researchers from Scripps and other institutions in California (Monterey Bay Aquarium Research Institute, U.S. Geological Survey, and Lawrence Berkeley National Laboratory).

Benefits

An adequate supply of natural gas at reasonable prices is critical to the economic and physical well being of the people of California. The proposed research will advance our understanding of a potentially significant new source of natural gas. A calibrated computer model is needed (1) to quantify the various processes involved in the formation and dissociation of methane hydrates, (2) to aid the exploration for methane hydrates by delineating the geologic conditions necessary for the presence of high hydrate saturations in oceanic sediments, and (3) to investigate effects of hydrate dissociation on seafloor stability.

Responsiveness to CEC Goals

A goal of the Energy Action Plan is to ensure a reliable supply of reasonably priced natural gas. At the present time, production of gas from conventional sources is being supplemented by unconventional gas such as coal bed methane. In the future, it will be necessary to identify other sources to meet the projected demand for natural gas. The proposed project is intended to aid the exploration for, and utilization of, natural gas hydrates.

Currently, the gas industry views hydrate research as risky and does not provide significant funding, either for exploration or for the development of technology for the utilization of gas hydrates. At present, hydrate research is supported mainly by the governments of Japan, the United States, and India. Most of this funding is directed towards exploration drilling. In past years SAIC's modeling work was supported by the Japanese program, but that program was recently redirected exclusively towards drilling. CPUC (California Public Utilities Commission) funding is requested to further advance the modeling effort.

Objectives

i) Use the existing 1-D simulator in parametric calculations to establish the conditions likely to result in undersea hydrate formation. The simulator incorporates all the pertinent physical mechanisms (burial history of deep sediments, in-situ generation of biogenic methane from organic carbon, migration of thermogenic methane from depth, fluid movement and expulsion, subsurface temperature/pressure changes, effect of grain/pore size, etc.).

ii) Based on the existing model, develop a fully three-dimensional computer simulator to model the time-dependent formation, decomposition, reformation and distribution of natural gas hydrates in specific marine environments.

iii) Calibrate the computer program by applying it to simulate hydrate distributions at various oceanic sites (Blake Ridge, Gulf of Mexico, Cascadia, and Nankai Trough).

iv) Use the calibrated model to help identify other promising sites for exploration, and to investigate the possible consequences of hydrate production for seafloor stability.

Budget

2005 : 250000
2006 : 250000
Other : 500000

Comments

The proposed research will be carried out over a four-year period. During 2005 and 2006, we will emphasize (1) parametric calculations using the 1-D simulator to identify physical conditions critical to the presence of undersea methane hydrates, (2) gathe

Project Concept #16: Natural Gas Reformer Hydrogen Refueler

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Description

Use NG to produce hydrogen in a small scale on-site reformer. The hydrogen would then be purified, compressed, stored, and dispensed to re-fuel fuel cell powered vehicles.

Benefits

From General Motors' well-to-wheel European study (Energy Consumption and Greenhouse Gas Emissions):

Gasoline ICE Vehicle (WTW): 2.8 MJ/km, 215 g GHG/km
NG ICE Vehicle (WTW): 2.7 MJ/km, 160 g GHG/km
NG-->H2-->Fuel Cell vehicle (WTW): 2.1 MJ/km, 120 g GHG/km

Responsiveness to CEC Goals

Energy efficiency and Environmental: from a well-to-wheel perspective, energy consumption and air pollution will be less than a gasoline or NG internal combustion engine powered vehicle.

Objectives

The demonstration of reformer refueler technology, i.e. validation of the technology.

Budget

2005 : 1500000
2006 : 500000
Other :

Comments

Project Concept #17: Low Income Gas Customer Technology R & D

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Description

Conservative data shows that there are 4.7 million people in Califonria living below the poverty line. Increases in natural gas costs have severely this sector of the population. This proposal will develop low-cost, high-efficiency equipment and appliances targeted to the low-income sector. Specific projects include a combination water/space heater system that eliminates the need to buy a furnace, triple integrated appliances, and a high-efficiency steam boiler concept for the multifamily market for heating and hot water.

Benefits

Benefits include energy savings, equipment first-cost savings, reductions in unpaid bills. Other benefits will be a reduction in expenditures for other Low Income Energy Assistance programs.

Responsiveness to CEC Goals

This project will develop technologies for an economic sector of California -- low income -- that is not currently being targeted by equipment manufacturers. This sector is in need of low cost equipment with increased energy efficiency.

Objectives

Key objectives are to develop low-cost appliances and technologies for the low-income market. This includes a low-cost 92% fully condensing combination gas water/space heater that uses an improved water-to-air heat exchanger in place of a gas furnace; a triple integrated appliance for gas heating, water heating and electric air conditioning; and an energy management device that incorporates intelligent learning to analyze HDD, occupancy habits, and budgetary constraints.

Budget

2005 : 500000
2006 : 500000
Other : 500,000 per year for two more years, for a total of 2,000,000

Comments

The California gas LDCs will support this project as it should reduce uncollectible debts. Part of the R & D will be to investigate equipment buyer decision-making, as the buyer is often not the equipment user in low-income housing.

Project Concept #18: Residential Gas Cooling

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Description

This project would develop a residential absorption-based 5-ton gas cooling system with Coefficient of Performance of at least 1.0 and costs no more than 30 percent above electric vapor-compression air conditioners. This project will take advantage of technology advanced in the generator absorber heat exchanger (GAX) R & D program, yet focus on cost reduction to bring down the additional costs of an absorption-driven system.

Benefits

Again, this project offers residential consumer options, higher efficiencies, lower energy bills for cooling, and reduced peak electricity usage.

Responsiveness to CEC Goals

This project will increase consumer options, is energy neutral (compared to a 3.0 electric cooling system and a 33 percent efficient electric generation and T & D system), and offers lower energy bills for cooling. This R & D is not otherwise being performed by the private or regulated energy sectors.

Objectives

The objective is to develop an absorption-based gas cooling system for the residential market (targeted to the "dry" California areas), with COP of at least 1.0 and costing no more than 30 percent above electric vapor compression systems.

Budget

2005 : 1000000
2006 : 1000000
Other : 1,000,000 annually for three more years (total 5 years, 5,000,000)

Comments

A low-cost, high efficiency gas cooling option is not being pursued by the private sector

Project Concept #19: Low NOx Gas Water Heater

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Description

Environmental regulatory bodies in California, Texas and other states are moving to forbid the use of gas water heaters that release more than 10ng/j (approximately 30 ppm) of NOx. This technology is currently not available from water heater manufacturers. This potential regulation could result in reduced choices for water heaters in California, forcing consumers to rely on electric water heaters only. This would simply exacerbate the already difficult electricity supply situation in California, and result in higher energy bills.

Benefits

This project will result in lower energy costs for California consumers, additional choices for consumers, and lower NOx emissions.

Responsiveness to CEC Goals

This project would advance technolgy, since the R & D is not currently being performed by GTI and there are no current products on the market. While manufacturers might be forced to perform such R & D, they could simply elect to sell electric water heaters instead.

Objectives

The key objective is to develop a low-NOx gas water heater that produces less than the 10ng/j NOx standards being considered by California and other states, while keeping first cost to no more than 10 percent higher than comparable "high NOx" gas water heaters. Overall efficiencies would be above 80 percent.

Budget

2005 : 250000
2006 : 250000
Other :

Comments

There are advanced low-NOx techniques developed by GTI for larger industrial combustion equipment, but they have not been tried on a smaller, residential scale. This could shorten the R & D cycle and increase the probablity of success.

Project Concept #20: LNG Interchangeability for Commercial and Industrial Users

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Description

The U.S. Energy Information Administration projects that importation and use of liquefied natural gas (LNG) will increase from 0.2 trillion cubic feet annually (Tcf) in 2002 to over 4.8 Tcf by 2025. As new imports of LNG reach beyond the traditional Trinidad-Tobago markets, the energy content of the LNG is projected to move from about 1030 Btu/cf today to over 1100 Btu/cf in the future. GTI recently completed a study on the impact of LNG on residential customers. This effort should be extended to commercial and industrial users, whose fuel and process specifications are even more exacting than residential users. For example, gas turbines can be adjusted to handle a wide range of fuels; however, once adjusted, they cannot handle significant fluctuations in gas quality. Low NOx burners may be sensitive to changes in fuel composition that affect flame geometry. Equipment operating with low excess air may be sensitive to changes in the fuel calorific value.

Benefits

Benefits are anticipated to be increased safety, efficiency and reduced emissions for commercial and industrial natural gas customers, especially considering the LNG mix and sites that may impact California in the near future.

Responsiveness to CEC Goals

There are small proprietery studies under way by LNG providers, but funding is not adequate considering the magnitude of fuel use by commercial and industrial customers and the amount of LNG projects to come into the United States, and particularly to California.

Objectives

The objectives are to develop a scientific understanding of the impact of high-Btu natural gas from LNG on burner tips for commercial and industrial applications, fuel and oxidant supply, mixing, and ratio control equipment performance; operate flame safety and monitoring equipment and burner emissions (CO, unburned hydrocarbons, and NOx) for a wide range of traditional and low-NOx burners; and develop recommendations for ameliorating these problems.

Budget

2005 : 1000000
2006 : 900000
Other :

Comments

This project may attract co-funding from other areas like Massachusetts, Louisana and Texas, states that may also be impacted by the siting and use of LNG. The GTI interchangeability study did find impacts on residential customers. The study is for sale

Project Concept #21: Clean Energy Technologies - Combined Utility Distribution Infrastructure Analyzer (CEC-CUDIA)

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Description

Recent studies sponsored by DOE and conducted by GTI reveal that distributed generation (DG), combined with application of energy efficient (EE) technologies and renewable energy power generation (REPG) can be strategically deployed within constrained utility distribution networks to effectively mitigate electric grid peak demand load problems. Targeted deployment of these technologies can not only defer, but even eliminate the need for costly grid circuit upgrades required to accommodate load growth. Currently ongoing efforts to accelerate the deployment of advanced DG, EE and renewables are not well integrated with gas and electric utilities' efforts to reduce capital costs by increasing utilization of their distribution infrastructure. Sophisiticated planning tools are required to determine how and where advanced technologies such as DG, EE and REPG can be effectively and economically deployed. This proposal will develop a tool that will help the CEC and CPUC to work with California utilities to improve utilization of their distribution infrastructures and to promote technically and economically feasible deployment of clean energy technologies directly benefiting California ratepayers.

Benefits

The project will minimize capital expense associated with upgrades of gas and electric distribution by identifying future "bottlenecks"; reduce the ratio of peak-to-total demands on the gas and electric distribution to increase infrastructure utilization factors and reduce the cost of delivery; enable the on-site use of heat produced by DG prime movers to increase the overall efficienty of fuel use and decrease customers' energy costs; and enable targeted private investment in these advanced technologies to that utilities control the deployment location, schedule and operating hours.

Responsiveness to CEC Goals

The project will optimize energy conservation and resource efficiency; promote customer and utility-owned distributed generation; ensure reliable supply of reasonably priced natural gas; and accelerate the state's goal for renewable generation.

Objectives

Based on GTI's experience in developing and managing projects relevant to this concept (see additional comments)the key objective is to develop a Clean Energy Technology - Combined Utility Distribution Infrastructure Analyzer software tool, or "Grid Optimizer" tool. The tool will target the deployment of DG, EE and REPG based on a variety of parameters such as location, climate zone, target building types and numbers, local gas and electric utility rates, and the system configuration. It will indicate ways to "flatten" the grid's load to make circuits more efficient.

Budget

2005 : 240000
2006 : 185000
Other :

Comments

A GTI team has developed other software tools that support the energy industry. Of primary interest is the Building Energy Analyzer, which provides lifecycle economic analysis for energy applications in commercial and industrial buildings. Please contac

Project Concept #22: Recycling Energy Program

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Description

Rising natural gas and electric prices have impacted California's industrial sector. In order to slow natural gas demand and improve the competitiveness of California industries, GTI proposes to partner with the California Public Interest Gas Research and Development Program to develop packaged systems for recovering wasted fuel and energy. Industries that could benefit include glass, chemicals, food, forest products, refineries, paper, automotive, plastics, oil, and natural gas compressor stations, letdown stations, and simple cycle gas turbines.

Benefits

This project will result in the capture of nearly a Quad of energy within the state. Specifically, the proposed products will capture normally wasted energy, reducing natural gas and electric energy demand; will increase energy reliability; will lower energy costs and increase competitiveness of key California industries; and provides essentially a "green" energy product due to its production from waste heat.

Responsiveness to CEC Goals

This project will optimize energy conservation and resource efficiency by converting wasted energy into electricity; will promote utility-owned DG; and will ensure reliable supply of reasonably priced natural gas by reducing peak electric and natural gas demand

Objectives

The goal of this program is to maximize the capture of wasted heat and fuel within California's industries. This will be accomplished by identifying the waste feedstock in California and matching it with the appropriate technolgoies and user industries; developing packaged plug and play systems for each of the selected industries; demonstrating the product in each of the selected industries; and communicating the solution to applicable facilities in California

Budget

2005 : 900000
2006 : 900000
Other : 3,000,000 (year 3);
1,200,000 (year 4)

Comments

There is additional cost-sharing for this project

Project Concept #23: Pressure Into Power (PIP)

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Description

This project offers an opportunity to reduce natural gas distribution costs by capturing waste energy at natural gas letdown stations and producing electricity at efficiencies of over 300 percent. The "free energy" is created by the pressure drop that occurs in the delivery of natural gas when moving the commodity from a high pressure pipeline to a lower pressure pipeline. This usually occurs at city gate stations. The most common method for reducing natural gas pressure at a city gate is a ball valve. A gas expansion ball valve functions much like a valve used to control water pressure and flow in a typical bathroom shower head. When gas is decompressed to a lower pressure, it expands and "free energy" is released. Once captured via the PIP technology, the energy is used to produce electricity. It can also be used to produce cooling for air conditioning or refrigeration. Currently there are 27 PIP systems installed and operating in Europe with a combined electrical generating capacity of about 20 MWs.

Benefits

The PIP system will capture the normally wasted energy from natural gas pressure reducing stations, producing essentially a renewable energy source. PIP systems will capture an otherwise wasted energy source, which not only increases supply but increases reliability. Economic benefits are realized when associated business opportunities, like making ice, are available at little or no cost.

Responsiveness to CEC Goals

This project will optimize energy conservation and resource efficiency by converting wasted energy into electricity; promote utility owned DG; ensure reliable supply of reasonably priced natural gas by reducing distribution system operating costs; and accelerate the state's goal for renewable generation b providing electricity from a waste or free energy source.

Objectives

The objective of this project is to introduce the PIP technology in the United States, and to develop the first demonstration project in California. Based on a prior market study, several suitable opportunities exist for the PIP technology in California. This would be a collaborative effort between GTI, a local utility, Dresser Inc,. and an ice manufacturer. GTI will develop a modular plug and play system which would be integrated with the PIP technology. GTI will also assist in the development of a conceptual design and repeatable bid package so the PIP technology may be developed and implemented throughout California.

Budget

2005 : 450000
2006 : 400000
Other : 50,000
in year 3

Comments

Additional funding will be provided by Dresser Inc.

Project Concept #24: GTI Packaged Water Desalination Unit

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Description

Meeting the demand for water, now and in the future, is fundamental to maintaining healthy California communities and a strong economy. In recent years, water desalination has reemerged as a viable technology to preserve and extend California's precious water supply. However, energy remains one of the primary barriers to successfully developing water desalination technology, both in terms of the high demand for energy in the desalination process and the high cost of energy. Developing a natural gas-fired water desalination technology that is energy efficient and small scale is a key objective of GTI's proposed packaged water desalination unit. GTI is proposing to develop a technology to help meet California's current and future demand for fresh water. The unit is a new application of existing and proven technology, and has the potential advantage of not only meeting its own energy requirements but also generating energy for sale.

Benefits

Currently there are only 16 permitted seawater desalination facilities in operation along the California coast, generating approximately 4,600 acre-feet per year of water, and approximately 40 brackish groundwater desalinating facilities generating 170,000 acre-feet per year. Even if all the planned facilities are built, they would yield a mere 530,000 acre feet of fresh water each year. Overcoming the technology issues that have plagued water desalination in the past will help California meet current and future demand for water and energy, and reducing costs for both. There are additional opportunities for a small unit, which can be placed more strategically than a larger unit.

Responsiveness to CEC Goals

This project will optimize energy conservation and resource efficiency by producing desalinized water more efficiently; promote utility-owned DG; and ensure reliable supply of reasonably priced electricity by reducing electric demand for water processing in California.

Objectives

The objective is to develop an energy efficient distributed water desalination unit that overcomes many of the technology barriers that have plagued desalination in the past: namely the high demand for energy. GTI will prepare a study outlining performance and economic data of the proposed unit, scale of application within California, and various pathways to commercialization. A prototype unit will be designed and tailored to the needs of a particular water resource and field demonstration site.

Budget

2005 : 550000
2006 : 700000
Other : 700,000 (year 3)

Comments

Project Concept #25: Restaurant heat recovery

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Description

Fast-food restaurants ventilation systems handle air and combustion products at high temperature. Most of the heat from cooking appliances goes up the stack. A heat recovery system for water heating, space heating or thermally activated cooling would enhance overall energy efficiency.

Refrigeration is a central need in restaurants and it is provided by electrically powered chillers. In times of power failure, restaurants lose revenue due to food spoilage. A thermally activated system that is co-fired with natural gas would eliminate this load from the grid and provide a safer, more economical operating environment for the restaurant.

Benefits

Reduced national energy consumption when factoring in efficiencies at the central plant, transmission and other losses. Reduces global warming gases.

Responsiveness to CEC Goals

Would lower the demand on the grid, and would lower operating cost at restaurants.

Objectives

Develop designs and prototypes of a heat recovery system for restaurants focusing on thermally activated cooling.

Budget

2005 : 750000
2006 : 1250000
Other : 3000000

Comments

Project Concept #26: Light commercial CHP

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Description

On-site power generation designed specifically for small commercial sites is needed to enhance power security and reliability. Small generators in the size range of 5 to 10kw can easily provide the electrical and thermal needs of small businesses. Such a system would lower the dependence on the grid and make more power available to residences.

Small piston engine generators are avialable today that can meet these requirements. Improvements in reliability and cost of manufacturing are needed to foster greater market acceptance.

Benefits

Reduced demands on the grid, increased power availability to customers, reduced greenhouse gases, higher overall utilization efficiency when considering transmission losses, generation at a central site etc. Higher source energy efficiency.

Responsiveness to CEC Goals

Reduces transmission loads and losses. Improves safety and security.

Objectives

Improved grid reliability, improved reliability for small commercial operators, availability of more power for residential customers.

Budget

2005 : 500000
2006 : 1000000
Other : 2000000

Comments

Project Concept #27: Organic Rankine Cycle System Development

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Description

Numerous applications for Micro CHP systems are difficult to address using conventional engine-driven systems either by virtue of scale of economy (a small electric generation requirement) or by the large thermal load for the application. Two such applications are commercial laundry facilities and car washes. Alternatively, there are applications where the requirements of the power generation are small, generation efficiency is not critical, and maintenance requirements for the system must be low, such as in a residential application. In both these scenarios, the Organic Rankine Cycle (ORC) Scroll Expander Micro CHP system shows promise for lower maintenance and maximum utilization. This project will fashion a Micro CHP system utilizing a 2.5 to 3 kW ORC generating unit in conjunction with various thermal utilization technologies to obtain optimized system configurations that will exhibit significant annual energy cost savings for the end user, as well as provide benefits to the public.

Benefits

The ORC Scroll Expander system is expected to achieve 20 percent annual energy cost savings when compared to grid-supplied electric and thermal energy needs; reduction of about 11 MWh per 1,000 ORC units installed annually; reduction of approximately 5,000 tons per 1,000 units installed each year; and the system meets CARB's 2007 NOx emissions requirements.

Responsiveness to CEC Goals

This project should provide significant financial (lower costs) and environmental (reduced emissions) benefits when compared to conventional grid-supplied electricity. Further, it enhances the reliability of the electric energy supply by providing on-site power generation that can help reduce peak load in California.

Objectives

The key objectives of the project are the development of viable commercial system models (both physical and anayltical) for the Organic Rankine Cycle system, and the development of a viable residential system model for the Organic Rankine Cycle. The models will provide financial and environmental data through comparisons with conventional grid-supplied electricity and thermal energy sources.

Budget

2005 : 400000
2006 : 250000
Other :

Comments

The intent of the project is to consider and screen various thermal energy utilization schemes in conjunction with this baseload micro CHP system. The modulating capabilities (up to 30 percent of full electric output) of the ORC system coupled with therm

Project Concept #28: Gas Engine-Drive Combination Heat Pump and Standby Generator

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Description

Residential and small commercial air conditioning loads contribute significantly to the peak electrical demand in California. Gas-fired alternatives are virtually nonexistent. The proposed appliance comprises a low-emission natural gas engine-driven generator set that supplies electricity to a standard hermetic compressor or pre-selected standby electrical loads. The system will use currently available and market-tested technology with high efficiency, low emissions, and significantly lower cost, smaller size, and longer life.

Benefits

The proposed project will enhance energy efficiency and reduce energy costs through the development and use of energy efficient consumer options for reducing or managing loads.

Responsiveness to CEC Goals

This R & D is not currently being performed by GTI and there are no current products available commercially. While manufacturers might be forced to perform such R & D at a later date, they could simply continue to sell electric air conditioners instead.

Objectives

The key objective of this project is to develop a gas engine-driven combination heat pump and standby generator with 25 percent higher total efficiency than conventional space conditioning systems. Additionally, this technology will enable homes to operate in a standby mode should grid electricity be interrupted.

Budget

2005 : 370000
2006 : 370000
Other :

Comments

Project Concept #29: Commercial Gas Fryer for Food Service

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Description

Current commercial gas fryers are about 60 percent fuel efficient. GTI proposes a new fryer combustion and heat transfer system that will increase the fryer efficiency to over 70 percent. In addition, cleaning time for this new fryer will be greatly decreased. California restaurants typically use multiple fryers in each store; the stores that use this new technology will realize a 20 percent reduction in fryer energy costs. This new technology will also reduce the heat transferred from the fryer into the conditioned space by about 30 percent.

Benefits

The benefits from this project will be lower energy costs for California restaurants, reduced energy use for space conditioning, and additional comfort in the kitchen.

Responsiveness to CEC Goals

This R & D is not currently being performed by GTI and there are no current products available in the market. While manufacturers may be forced to perform such R & D in the future, the could elect to sell only electric fryers.

Objectives

The key obnjectives are to develop a higher efficiency gas-fired commercial food service fryer while keeping first cost no more than 10 percent higher than conventional fryers. At the same time, the project seeks to reduce heat gain into the kitchen space by 30 percent over conventional fryers, thereby reducing the air conditioning requirements of the kitchen.

Budget

2005 : 300000
2006 :
Other :

Comments

18 month project

Project Concept #30: Survey Existing Hot Water Distribution Systems and Perceived Performance

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Description

Greater than 85% of California homes heat water with gas. In order to define a baseline from which to measure future hot water distribution system improvements, a more detailed understanding of what is current and past practice for these residential systems is needed. Since the homeowner's perception of the performance of their hot water system will influence their interest in and willingness to seek alternatives, what is important to the homeowner and how they evaluate their current system also needs to be determined.

To determine the hot water distribution systems used in existing housing, an analysis of a number of data sets (e.g. census data) and other information sources would be employed. This data would provide typical characteristics for hot water distribution systems in various time periods. It would include: number of residences, average size, average number of bathrooms, average number of occupants, typical hot water consuming fixtures, typical location of distribution system, and typical piping material used.

To determine what is currently being built, a survey of a representative sample of California builders, plumbers, building inspectors, etc. would be accomplished. This survey would identify what plumbing systems are currently being installed, the trends in new construction, and the respondent's evaluation of how well these systems work.

An additional survey to determine what is currently being built would be directed at major hot water distribution system materials and equipment suppliers or trade associations as to their annual sales in physical units of various key elements of the system. This would enable the project to compare this information with that provided by those involved in the installation of current systems.

To identify the perceived performance of their existing hot water distribution system, a survey of a sample of homeowners and landlords or renters would be accomplished. Collaboration with water supply agencies might enable the project to include the survey with the homeowners' bills. The completed survey could be returned to the project in an SAE or with their payment to the water agency, which would review their data and forward the surveys to the project.

Benefits

In addition to a more definitive and accurate understanding of existing HWDS, it is expected that this information will assist in the identification of what consumers value in regard to hot water, what the system installers consider important and which areas exist for improvement. It will also guide the marketing of those improvements, and will establish useful contacts in the residential construction sector that could assist in the implementation of those improvements.

All of the information gained from this effort will be of use in focusing the other related HWDS tasks to be of maximum benefit in identifying existing system shortcoming and gaining acceptance of new systems and practices. These surveys won't tell what to do to solve the problem, but they will help identify what the problems are.

Responsiveness to CEC Goals

This project's focus is on energy efficiency, conservation and environmental issues associated with residential water heating and use in California homes.

It supports the State Energy policy, see California Energy Action Plan by providing the data needed to evaluate comprehensive improvements in energy and water conservation while also saving the rate payers utility costs.

An ORNL study has shown it offer a high probability of providing significant performance and cost benefits to the general public.

Finally it considers opportunities for collaboration and co-funding with other entities such as water and energy utilities as well as the home building industry.

Objectives

Analyze data sets and information sources described above to determine the characteristics of hot water distribution systems in existing housing. Estimated effort: 2 to 3 person months.

Prepare, disseminate and collect surveys and analyze data from those involved in the installation and repair of these systems including materials manufacturers. Estimated effort: ~2 person months.

Prepare, disseminate and collect surveys and analyze data from a sample of existing homeowners and landlords/renters through water supply agencies. Estimated effort: 1 to 2 person months.

Budget

2005 : 125,000 to 175,000
2006 :
Other :

Comments

Project Concept #31: Combustion Sensor Development

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Description

New technology is emerging that may permit combustion systems to have non-intrusive controls that monitor concentrations of carbon monoxide and carbon dioxide. This R & D project encompasses the development of controls utilizing low-cost, non-intrusive sensors for appliance control. Controls based on carbon dioxide concentrations would enable appliances to adapt to changing venting conditions to optimize and maintain efficiency under all conditions. Additionally, these sensors can enable effective modulating control of appliances. Carbon monoxide base controls would limit appliance emissions and improve safety. Fuel savings from efficiency tuned and controlled appliances will conservatively yield 5 to 10 percent savings in both residential and commercial applications. Additionally, these benefits can be extended into process heating applications.

Benefits

The benefits of this technology include a 5 to 10 percent increase in appliance combustion efficiency, resulting in savings for California residential customers of approximately $16 to $32 per year. In addition, monitoring of appliances through these sensors can provide safer appliances for consumers. And sensor-controlled appliances will ensure operation of appliances within permissible emissions limits.

Responsiveness to CEC Goals

This project will further the development of necessary combustion sensor technology while improving the efficiency, safety and reliability of the appliances into which these sensors will be integrated. Currently there is little or no market incentive for manufacturers to expend the R & D investment dollars toward these sensors. The public interest is served by the safety, health and energy savings benefits this technology could provide.

Objectives

The key objectives are to identify, compare and screen candidate technologies for CO, CO2 and possibly O2 based on the potential to be made compact, cost effective, durable, stable, long-lived and environmetally friendly. In addition, the project will characterize sensor technologies for applicability within either control or monitoring applications; create sensor/control platforms for appliance applications; implement and lab test these sensor technologies; develop controls and algorithms to integrate these sensors into various appliances; and field demonstrate and remotely monitor these sensor technologies which have been integrated into a variety of residential and commercial appliances.

Budget

2005 : 500000
2006 : 500000
Other : 600,000
in year 3;
700,000
in year 4

Comments

The advancement of cost-effective combustion sensor technology could revolutionize the residential and commercial appliance industries. These industries tend not to invest in research due to the commodity cost of their product. These sensors will greatl

Project Concept #32: Stirling Engine-Based Cooling/Heat Pump Equipment

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Description

The free piston Sriling engine technology has evolved to the point that reliable, no-maintenance, long lief equipment (>60,000 hours) are currently being produced for various applications. GTI proposes to develop a residential/small commercial sized gas-fired air conditioner/heat pump based on free piston Stirling engine technology. The system will have low emissions that comply with CARB's 2007 requirements while providing high COP. The proposed project addresses the CEC goal of enhancing energy efficiency and reducing energy costs through the development and use of energy efficient consumer options for reducing peak electricial load, or managing loads.

Benefits

This project will provide enhanced energy efficiency and reduced energy costs, as well as energy efficient consumer options for reducing peak electrical load or managing loads.

Responsiveness to CEC Goals

This R & D is not currently being performed by GTI and there are no current gas-fired heat pump products on the market.

Objectives

The key objective is to develop a gas-fired Stirling engine low-maintenance air conditioner with a cooling COP of at least 1.0 and an adidtional heat pump model with a heating COP of 1.5.

Budget

2005 : 370000
2006 : 370000
Other :

Comments

The initial study will include a design evaluation of transfering the Stirling free piston work to a compressor (such as using a linear alternator to generate electricity to drive a compressor or a direct linkage system to a novel linear compressor). The

Project Concept #33: Determination of Residential Hot Water Consumption and Waste

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Description

While over 85% of California homes heat water with gas there is very little hot water use data (amount, frequency, purpose) currently available. What is available samples only a few households, not a statistically significant quantity or a representative sample of the population. Households that have been the subject of these measurements have often been those of the researcher or friends that agree to cooperate. Some of the studies are of sufficient age as to no longer reflect the system's current performance due to changes in population demographics.

The lack of data to quantify typical residential hot water usage severely restricts the ability to accurately assess the merits of various hot water distribution system configurations and options. For example, reducing the size of piping used in the distribution system offers an opportunity for both water and energy savings. Smaller diameter pipe will reduce the amount of hot water that loses heat during stagnant periods. But whether the pipe size can be reduced and how much depends on the pattern of hot water use.

There would be a significant benefit to acquire representative data from many households throughout California over a relatively short time, and at modest cost. By acquiring this significant sample of representative households, realistic patterns of hot water use could be identified and documented. These use patterns would be used to analytically evaluate the benefits of various configurations and technologies for hot water delivery. This evaluation would have a high probability of being correct since it is based on an appropriate sampling of water use.

This sampling could be achieved by a measurement approach that uses equipment which can be rapidly installed, with minimal disruption to the household, and then readily moved to another location once data is acquired over a length of time adequate to be considered representative of hot water use patterns (perhaps one or two weeks). A cooperative effort with multiple utilities is envisioned, to facilitate selection and willing participation of a representative sampling of households.

Benefits

A sampling of water use patterns that is representative of use throughout California can be used to reevaluate the pipe sizing requirements and plumbing designs included in the current plumbing and building codes. This reevaluation is likely to show that smaller size pipe can be used successfully for hot water distribution systems, thereby lowering initial costs, speeding the delivery of hot water to the fixture, and saving significant amounts of both water and energy.

Another use of this data will be to assist in achieving appropriate simulation model input parameters used in the design of HWDS for new construction and the evaluation of various system types and options (such as the use of insulation) which are very dependent on the water use pattern. Validated simulation models using appropriate use patterns will also assist in the development of energy and water codes, such as California's Title 24.

Finally, the device developed to monitor hot water use patterns could also be used to measure other parameters of use in the validation of computer simulation models. For this application, additional information about the particular system being monitored would also have to be obtained, including pipe lengths, location, materials and, ambient temperature around the pipes.

Responsiveness to CEC Goals

This project focuses on energy efficiency, conservation and environmental issues associated with residential hot water use.

It supports State Energy policy in providing data that can be used to reduce waste of natural gas and water.

It offers a high probability of providing benefits to the general public through lower utility costs and reduced environment impacts.

It considers opportunities for collaboration and co-funding opportunities with other entities including CUWCC, water providers, utilities, municipalities, etc.

Objectives

Accomplish a thorough market and literature review of current technologies for sensing and recording water temperature and flow rate. Also look at potential for monitoring water heater energy consumption. Review technologies that are currently on the market. Speak with other researchers regarding their monitoring technologies and techniques. Summarize the findings of this effort as input to subsequent tasks.

Develop a data acquisition system to measure hot water consumption and patterns of use. This task is to develop the instrumentation and distributed data acquisition system (DAQ) for hot water flow and temperature characterization in the field. The DAQ could employ wireless remote non-intrusive sensors so that installation into residences can be done quickly. Assess the rapidly developing wireless sensing and networking technologies before making a decision.

Conduct field measurements on a large number of residences. Characterize each residence by occupant number, ages, types of fixtures and appliances. For each residence, measurements of hot/cold flows, flow duration, timing, and delivery temperatures at each fixture will be done using the DAQ technology developed above. Analyze data by draws to determine type of draw (e.g. bath), total water in draw, mixed temperature at point of use, flow of hot water, etc. Analyze the impact of varying occupant behavior on different hot water distribution systems. Perform a behavior analysis to determine how customers change how they use water if hot is readily available at fixture.

Budget

2005 : 350,000 to 450,00
2006 : 0
Other : 100,000 to 150,000

Comments

Project Concept #34: Technology development for small Landfill Gas energy recovery projects

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Description

According to the USEPA, California has 76 active landfill gas energy recovery systems with another 274 potential sites. Energy recovery at the 274 sites is not economically viable using conventional LFG technology because of poor methane quality or low methane generation. Electrical generation is simple and a preferred method of energy recovery, however utilities pay a low value for this power making these projects unprofitable. The proposed process targets energy development at small landfills. The reason the proposed system can work at these sites is because the high value of the products. The proposed concept is to convert methane gas to hydrogen and carbon black. A small side stream of landfill gas would be used to either make electricity or to generate heat needed for the process.

Landfill gas will be heated to a plasma state to cause hydrogen and carbon to disassociate. These will be the saleable products. Two methods will be used to verify the process and energy balance. The first is to model the process using University of Southern California's (USC) CFD code. The second is laboratory testing to confirm the modeling results. Pseudo landfill gas will be heated using USC's arcjet engine or an electric heater. Testing will be performed on methane, carbon dioxide and a mixture of these gases. Once the testing is complete, a preliminary project cost and market evaluation will be made to determine the economic viability of the process.

Phase 2 is to do a field test of the process. GCE has been working on a process to make carbon black using starved air combustion. This process is difficult to control and has a significant carbon and hydrogen losses. Therefore GCE has a stainless steel reformer/separator vessel available for use for the field test using the subject technology.

Benefits

The ability to produce higher profit-margin products like hydrogen and carbon black from LFG has the potential of making it economically viable to remove the NMOCs from LFG, with corresponding environmental benefits. Preliminary estimates show that the potential revenue of the product from a moderately small 500 SCFM landfill gas (250 scfm methane) project will be about $1,500,000 per year. The same project generating electricity will generate revenue of about $540,000 per year at $0.05/kWh or $1,325,800 as medium BTU gas sales if the gas is sold retail for $9.90 MMBTU's. The small amount of LFG available isn't sufficient to justify installation of a medium BTU project because of the long pipelines normally required. Thus there is a great economic incentive to use the relatively low cost landfill gas, especially given the high potential revenue.

The proposed plasma technology, if proven feasible, has the potential to revolutionize the landfill gas industry. It is simple in its inception and design, robust, and potentially applicable to both small and large landfill sites. In our opinion, it promises to be very competitive to conventional technologies like steam reforming of natural gas, since LFG is a renewable, relatively cheap fuel.

Responsiveness to CEC Goals

The project/technology provides one or more of the following public benefits:

1. By using LFG as the feed fuel the technology will convert a waste gas that does not have a market value into a usable product. This should reduce overall air emissions because less landfill gas will be flared without beneficial use. The use of LFG will also allow pipeline methane gas to be diverted to other uses.
2. Landfill gas is a renewable energy source.
3. Landfills are distributed throughout the state. This could benefit areas that are short of energy by providing a local source of hydrogen gas.

GCE has been working with a developer to a to a limited extent on potential conversion processes for methane gas to hydrogen and carbon black. The development costs have been higher than they could continue to fund. Additionally, the duration of the technology development will take several years to complete making it more risky for private funding. We are seeking public funding to continue this development.

Objectives

1. Perform a literature search to determine thermodynamic properties of the gases during and following reforming.
2. Determine the effect of CO2 and air in the methane for safety and process efficiency.
3. Prepare a working process flow diagram.
4. Numerical simulation by USC of the process using reactive-flow CFD code. Determine process conditions needed for the system to work.
5. USC to perform bench scale testing using a 1 kW arcjet engine or an electric heater to heat the gas to a plasma state.
6. Quantify the product gases and the energy balance around all systems.
7. Examine the carbon black structure to determine it's potential worth.
8. Prepare drawings for a modified reactor vessel and separator. Estimate the cost of the modified process.
9. Perform field-testing on the proposed process using landfill gas fuel. Examine the carbon black structure and test for contaminants.
10. Determine market value for the carbon black and hydrogen product.
11. Prepare a final report of findings and recommendations.

Budget

2005 : 95000
2006 : 145000
Other :

Comments

The proposed landfill gas development is unique because landfill gas has never been converted to hydrogen and carbon black. The reason this project can work financially is because of the high value of the carbon black. Granted, some of the energy will h

Project Concept #35: Low-Cost commercial boilers and water heaters

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Description

Commercial buildings consume over 2 quads of natural gas energy in the United States. More than 70% of all commercial buildings use gas for water heating, and about 17% use heating boilers. Although condensing water heaters are available with thermal efficiencies on the order of 95% or more, most buildings owners and operators purchase non-condensing water heaters with thermal efficiencies on the order of about 80%. The primary reason for selecting the less efficient equipment is the substantial price premium of condensing commercial water heaters over non-condensing equipment. Development of inexpensive condensing boilers and water-heaters that could provide payback periods of one to two years could reduce natural-gas energy consumption for this purpose by up to 15 percent. Such equipment should have a price premium of not more than 25% compared to basic non-condensing versions.

Benefits

Lower operating cost for owners, lower emissions, less greenhouse gas

Responsiveness to CEC Goals

Energy savings, reduced emissions

Objectives

Develop low cost boilers and water heaters for commercial application that have the same efficiency as higher-cost versions.

Budget

2005 : 500000
2006 : 1000000
Other : 1500000

Comments

Project Concept #36: Next Generation Instantaneous Water Heater R&D

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Description

Recent standards to improve safety and increase efficiency in gas water heating have led to a transformation of that market that includes renewed interest in instantaneous water heater technology, particularly with zero or low-energy home builders. To date manufacturers have adopted European and Japanese designs with some modifications to the U.S.market. The technology can offer higher efficiency -- 83 percent EF compared to 57 EF -- but the current generation of instantaneous water heaters has issues that limit production potential and acceptance in the marketplace. While efficiency is as good as available storage-type water heaters, it comes at a higher cost. And there are some issues surrounding venting requirements. Development and direct implementation of the next-generation technology would focus on component and system design. GTI would work directly with suppliers to the four major water heater manufacturers to address common design and performance issues, and work with individual manufacturers to implement the improved technology.

Benefits

Natural gas water heaters have a 79 percent market share in the California residential market, and installed in 9 million homes. Assuming a 25 percent market share for the next generation water heater, 2.3 million homes will realize an energy savings of 57 percent, or 108 therms per home. This results in annual savings in natural gas of 26 Bcf per year or $130 million in savings to California consumers. Additional benefits include improved operational performance and an 80 percent reduction in emissions compared to today's technology.

Responsiveness to CEC Goals

This R&D benefits public interest through the energy savings which accrue to the consumer and ratepayers, and by pushing the bounds of efficiency while maintaining, if not improving, reliability and safety. Without this technology development, next generation instantanous water heaters would be 8-10 years away.

Objectives

The key objective of this project is to develop the next generation instanteous water heater and components. Specific development areas include power reduction/elimination using solar assist or power generation by microcombustion; improved heat exchanger life and efficiency; low NOx burner <20 ppmv, design and integration (80 percent emissions reduction); and improved maintenance requirements using advanced technology to reduce mineral build-up and sensor fouling

Budget

2005 : 750000
2006 : 750000
Other : 750,000
(3 years)

Comments

The gas LDCs, major component manufacturers and water heater manufacturers will also support this R&D

Project Concept #37: Transportable Biomass Gasification Plants

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Description

Develop a transportable gasification power system. This will lead to better utilization of biomass as a dispersed energy resource. The system should be designed with modular components of a size to deliver electricity in the range of 0.5 to 5 MW. The size would be dependent on the type of engine powered by the fuel gas produced by the system. Biomass conversion used in combustion engines can be more energy efficient than current biomass recovery technologies that burn the biomass in boilers and generate steam to recover useful energy.

Because these systems are relatively small, detailed engineering to design a package plant ready for construction will be a relatively large percentage of the system cost. For this reason, a package design that minimizes future engineering costs must be developed.

Repeat installations must have minimal engineering to be cost effective.

The program should be developed in two phases: 1) Phase I: Develop preliminary design and cost estimate a transportable biomass power plant (multiple awards). 2) Phase II: Select 1 or 2 systems with the best concepts. Prepare a detailed engineering design for a prototype plant to demonstrate each selected concept.

Once the design is completed, demonstration of the prototype units can be proposed in future solicitations. Larger amounts of participant cofunding would be anticipated in this phase.

Benefits

Biomass is a renewable energy source that is considered a carbon dioxide neutral fuel. A 5 MW power plant can reduce carbon dioxide emissions by about 20 tons/year compared to generation by alternative means. This same power plant would likely save about 345,000 scf/yr of natural gas for alternative uses.

Responsiveness to CEC Goals

This project benefits the public interest in the following manner:

- Biomass is a renewable energy source and does not contribute to global climate change. Energy generated conserves premium fossil fuels that would otherwise be used for electricity supply.
- The small scale of the project 0.5 – 5 MW will allow siting on local distribution lines. This provides voltage support in rural areas and reduces the demand on high-voltage transmission systems. This provides greater energy security for the public.

Objectives

Biomass energy constitutes a major fraction of renewable energy currently used in California. However there are significant resources still not being fully exploited. The development of modular gasification systems would provide a means of cost effectively deploying this high efficiency technology for distributed energy generation in areas where the biomass materials are available, reducing transportation costs for the fuel.

There is a demand for this same technology nationally (and world wide). A barrier has been the high engineering cost to develop prototype units for testing.

Budget

2005 : 400000
2006 : 1500000
Other : 2000000

Comments

GTI has conducted a variety of studies for gasification of biomass using a wide array of feedstocks over the past 20 years. We believe the technology can be developed for modular scale systems that can be readily replicated to reduce costs. Recent discu

Project Concept #38: Novel Microturbine for Distributed Electricy and/or Combined Heat and Cooling

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Description

California is promoting clean and efficient distributed generation (DG)and cogeneration as a key component of its energy system. The novel 500 kW microturbine combined with a boiler/absorption chiller can meet this need for clean, small non-catalytic CHP generation in California. The technology uses advanced combustion staging and recuperation for the unit component, and advanced non-catalytic combustion NOx control techniques for the heat utilization component of the combined system.

Benefits

Clean distributed cogeneration is envisioned by California as a key component of its current and future energy system. The technology will lower the costs for California consumers through increased energy conservation and efficiency, and through significantly improved environmental impacts (lower emissions).

Responsiveness to CEC Goals

This R&D is not currently being performed by GTI and there are no current products on the market meeting required costs, efficiency and emissions targets. Original equipment manufacturers do not have a technology capable of meeting current needs and do not have sufficient R&D resources to develop the technology without public support.

Objectives

The objective is to develop a novel 500 kW microturbine and/or combined heat and cooling generation unit with the following performance goals: power output 500 kW; fuel-to-electricity efficiency of 42 percent; NOx <2ppm (@15%O2); thermal efficiency in CHP at 85 percent; no catalyst required for emission control while emissions are controlled by advanced combustion methods.

Budget

2005 : 500000
2006 : 500000
Other : 450,000
3 year project

Comments

$1.45 million in co-funding is anticipated. The advanced combustion methods for emissions control developed by GTI will replace expensive catalytic NOx control techniques, improving costs, reliability and market acceptance of the technolog.

Project Concept #39: Non-Catalytic Self-Powered Hydrogen Production Unit

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Description

This project will develop and demonstrate a non-catalytic, self-powered distributed hydrogen production unit in which a Partial Oxidation Gas Turbine (POGT) will be used as a non-catalytic reformer to supply fuel gas to the system while providing the necessary electricity to power the unit as a whole. The development of the POGT is currently being co-funded by the CEC.

Benefits

Development of clean, efficient hydrogen and power generation technologies will lower the energy costs for California consumers, and facilitate introduction of new DG technologies.

Responsiveness to CEC Goals

This R&D is not currently being performed by GTI and a laboratory demonstration of efficient, low-cost, self-powered hydrogen production will support the development of the hydrogen infrastructure (Hydrogen Highway)for California and the rest of the nation.

Objectives

The key objective is to develop a self-powered hydrogen production unit with a flexible ratio of hydrogen-to-electricity to expand the use of hydrogen as an energy carrier. The performance targets are: minimum 98 percent and up to 99.8 percent purity hydrogen with the balance of nitrogen and argon generated at a cost of 36 cents per 100 cubic feet of hydrogen, and at an overall efficiency of 85 percent for the combined hydrogen and electricity generation.

Budget

2005 : 1300000
2006 :
Other : 30 month project duration

Comments

$1.4 million in co-funding is anticipated. California companies such as Solar Turbines and Alturdyne Power Systems, who are participating in the POGT project, will have further incentive to develop new turbines, thereby increasing manufacturing jobs in C

Project Concept #40: Integrated Plasma Fuel Cell (IPFC) Process Test Stand

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Description

Proposed is a two-year, $2 million laboratory test stand for a nominal 100-watt Integrated Plasma Fuel Cell (IPFC) Process electricity and hydrogen plant. The test stand would integrate and operate a combined cycle process including a Hydrogen Plasma Black Reactor and a Direct Carbon Fuel Cell (DCFC). Natural gas fuel would be used. The IPFC process is described at www.hceco.com.

A Hydrogen Plasma Black Reactor would electrothermally crack a natural gas fuel to carbon and hydrogen. The hydrogen would be available for use in the hydrogen economy. A Direct Carbon Fuel Cell would electrochemically convert the carbon to electricity, which would be available for use.

A significant amount of design and engineering work is required to ready the IPFC process for the proposed integrated laboratory test stand operation. The components have never been integrated and this requires design and testing work to accomplish.

An IPFC process electricity and hydrogen generating system could be deployed in close proximity to the loads.

The proposed Integrated Plasma Fuel Cell Process test stand will not utilize combustion. No burning of the fossil fuel is involved in the process. The processes are electrothermal and electrochemical in nature. The Hydrogen Plasma Black Reactor is an invention of Kvaerner (now Aker Kvaerner) of Norway. It cracks a fossil or biomass fuel into hydrogen, carbon and other components. The carbon from this reactor has been tested and it works well with the Direct Carbon Fuel Cell.

Benefits

The energy efficiency of an operating unit is expected to be between 80 and 90% and, as a result, will produce far less carbon dioxide than a combustion system for the production of electricity and hydrogen.

Responsiveness to CEC Goals

The Test Stand is an essential research and development precursor to commercial availability of a very efficient, low pollution process, which could be deployed in California at anticipated competitive rates for electricity and hydrogen. This project is not being funded by any competitive or regulated entities.

Objectives

A test stand for an IPFC process plant will be designed, built and operated to establish feasibility of a potentially highly efficient process for electricity and hydrogen production.

Budget

2005 : 700000
2006 : 1300000
Other : 2000000

Comments

See www.hceco.com for more information.

Project Concept #41: Development and Demonstration of Technologies to Improve Energy and Emissions Performance in Biomass

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Description

The combustion of biosolids and solid waste fuels such as municipal solid waste (MSW) in stoker-type boilers is an attractive option for energy production due to the relatively low cost and renewable nature of the fuels. The use of renewable and waste fuels reduces dependence on fossil fuels and can result in a net reduction in CO2 released to the environment. The firing of these fuels is often limited, however, by a number of fuel quality issues, including relatively low and variable heating value, high moisture content, high fuel bound nitrogen content, and the presence of chlorinated chemicals such as dioxins and furans as byproducts of the combustion process. The strategic use of a small portion (3-15%)of natural gas in a reburning arrangement can result in significant improvements in both the energy and environmental performace of combustion-based waste-to-energy systems.

Benefits

Benefits include reduced dependence on fossil fuel-based electricity production; improvement in boiler operability and availability with low-quality fuels; combustion-based reduction of NOx emissions by 50-70 percent; increase of boiler efficiency by one to three percent; reduction of dioxins and furans by 80 percent without post-combustion cleaning; and reduced operating costs with less than a two-year payback.

Responsiveness to CEC Goals

Development and demonstration of gas reburning technology is not currently being performed for agricultural wastes or MSW. The technology has not yet been demonstrated in California for any fuel. Wast-to-energy facilities are unlikely to fund such research on their own.

Objectives

The objectives of the project are developmennt and demonstration of gas reburning technology for reduced emissions and increassed efficiency in biosolids and MSW-fired energy facilities to improve bioler efficiency and emissions performance.

Budget

2005 : 250000
2006 : 250000
Other : 250,000
(three year project)
750,000 total

Comments

The initial field development and demonstration of GTI reburinig technology was conducted on an MSW waste-to-energy facility in Minnesota in the mid-1990s. The technology was licensed by Takuma Corporation and used in two new waste-to-energy facilities i

Project Concept #42: Super Boiler for Combined Steam and Hot Water in Hospitals, Institutional and Commercial Buildings

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Description

Gas-fired commercial boilers in California consume about 80 billion cubic feet of natural gas and produce 960 tons of NOx per year. The Super Boiler, soon to be demonstrated in the industrial market, is a new steam boiler technology that will reach 94 percent energy efficiency and less than 5 ppmv NOx emissions (@3%O2). Currently, the Super Boiler is in late stages of development and is slated for a Southern California industrial field demonstration in early 2005. If the technology were implemented for commercial buildings, particularly hospitals and universities, it could cut gas consumption by 20 percent, saving up to 16 billion cubic feet, and cut NOx emissions by 83 percent. This would avoid up to 795 tons of NOx. A Super Boiler design that would provide both hot water and steam in a single package is being contemplated, and would be an attractive alternative to burner retrofits and/or tailpipe emissions controls to meet future air quality requlations while increasing efficiency and reducing greenhouse gas emissions. The Super Boiler is also engineered to be up to 50 percent lighter and more compact than conventional boilers, making sitting requirements easier.

Benefits

The estimated benefits of Super Boiler implementation in California for commercial facilities include saving up to 16 billion cubic feet of natural gas and avoiding up to 795 tons of of NOx emissions each year. The increased efficiency would also avoid up to 920,000 tons of CO2 emissions.

Responsiveness to CEC Goals

This combined hot water/steam Super Boiler is not currently under development by GTI or any other entity. Boiler manufacturers do not have the resources to develop this type of product without public assistance. Facility operators faced with meeting stict air quality requirements generally have no cost-effective alternative to installing complex and expensive catalytic NOx reduction equipment. This project would enhance rather than degrade energy efficiency due to the ultra-low NOx combustion equipment.

Objectives

Key objectives are to develop and demonstrate a combined hot water/steam Super Boiler specifically suited to commercial buildings. The outcome of the project would be a 100-300 BHP field demonstration in a California commercial site that could consistently deliver 94 percent fuel efficiency (HHV basis) while meeting an emissions goal of 5 ppmv NOx and 30 ppmv CO2 (all @3%O2) over the entire operating range. The boiler would also be designed to modulate the relative outputs of hot water and steam to respond to facility needs, and would have a footprint 50 percent smaller than that of a conventional unit.

Budget

2005 : 500000
2006 : 500000
Other : 500,000
3 year project, total cost of
3,000,000

Comments

The Super Boiler has already received significant funding support from DOE, GTI, manufacturing partner Cleaver-Brooks, and SoCal Gas Company. It is the first time that combustion, heat transfer, heat recovery and controls innovations have all been compre

Project Concept #43: Power Generation from Waste Heat

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Description

Many gas-fired industrial processes lose heat that can never be efficiently recovered. Commonly this heat is in warm wastewater streams or exhaust gas streams at 100 to 500 degrees. Current heat recovery technology cannot efficiently recover this low-level heat. Recovery of this heat by directly converting a portion of it (10 to 25 percent)to electricity can significantly reduce energy consumption and decrease harmful emissions.

Benefits

Benefits include a decrease in fuel gas consumption and a decrease in all emissions including NOx, CO, CO2 and particulates.

Responsiveness to CEC Goals

This project provides increased fuel efficiency via production of electricity from low-grade waste heat conversion devices.

Objectives

The objective is this project is to demonstrate the conversion of waste heat to electricity through advanced waste heat conversion devices.

Budget

2005 : 500000
2006 : 500000
Other :

Comments

Project Concept #44: Low-Cost Gas Meter for Individual Industrial Equipment

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Description

Accurate gas metering offers industrial gas users the ability to maximize performance and efficiency of equipment and processes. Meters currently available are too bulky and too costly to be installed in many locations. Low-cost metering systems that are easily installed, require low maintenance, and are inexpensive would be attractive to many industrial customers. The meters provide immediate as well as on-going energy savings, emissions reductions, and process improvements.

Available gas meters rely on diaphragm or thermal conductivity measurements. The new approaches must be faster, rugged, simpler, and easliy integrated into an industrial setting. Sample approaches include optical and acoustic methods.

Benefits

This technology lowers the cost of gas use to the ratepayer, makes gas use cleaner, more efficient, simpler, and makes production more efficient.

Responsiveness to CEC Goals

Safety will be improved by simplifying gas supply and metering. Efficiency improvements will reduce gas consumption and improve production efficiency, thereby providing direct benefits to users. Environmental benefits will be realized from better process control. There are already gas metering systems available. Evolutionary change requiring public support is needed to advance this technology.

Objectives

The objective of this project is to decrease the cost of accurately monitoring gas use. This will lower the cost of gas use, save energy, and reduce emissions from industrial gas equipment. The final objective is to make gas, a lower cost energy source, more attractive to end users.

Budget

2005 : 400000
2006 : 400000
Other : 400,000
(3 year project, total 1.200,000)

Comments

Project Concept #45: New Concepts in High Efficiency Natural Gas Fired Space Heating

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Description

Perhaps the most fundamental residential utility is space heating. Even homes lacking running water will still have a means of heating the indoor space. Most homes in the U.S. are heated with forced hot air which in most cases is supplied by a centrally located natural gas fired furnace. Ductwork is used to distribute hot air throughout the residence. While gas fired furnaces can be very efficient, the uninsulated and leaking ductwork found in most homes extracts a considerable penalty on the overall heating system efficiency. Attention has recently been focused on this problem and many states are beginning to require high efficiency distribution systems in new homes. However, a fundamental problem remains in that the distribution systems typically require heat to be delivered to the entire home based on control by a single centrally located thermostat. It is not currently practical to break up forced hot air heating systems into multiple, preferably room-by-room, zones controlled by individual thermostats. While its operating cost can be rather high, it has long been recognized that baseboard electric resistance heating can be extremely efficient as it lends itself to highly multiple zoning. The actual generation of heat is distributed on a room-by-room basis (or more discretely) and each baseboard unit is controlled by its own thermostat. Further efficiency improvement in such a distributed heating system is possible with the use of smart controls that incorporate time-of-day functions and occupancy sensors. New and innovative concepts are needed that enable natural gas fired heating systems to meet or exceed the energy efficiency potential of a smart-controlled distributed electric heating system. Concepts should go beyond the scope of typical incremental product improvement to existing HVAC equipment. Ideally new concepts should also be amenable to retrofit installation.

Benefits

The principal benefit of the proposed project concept to the public at large is the reduced consumption of natural resources accompanied by the reduction in emission of pollutants and greenhouse gases associated with the combustion of natural gas for space heating. These benefits accrue regardless of whether an individual lives in a home using the technology. For those individuals who do make direct use of the technology in their homes, an additional benefit is the reduced cost for residential space heating. In addition, technologies developed under the proposed project concept have the potential to offer greater personal comfort by tailoring the interior climate to suit individual needs and preferences.

Responsiveness to CEC Goals

This proposed project concept is in the public interest in that it has the potential to increase the energy efficiency of residential space heating and thereby reduce the consumption of natural resources and emission of pollutants and greenhouse gases associated with the combustion of natural gas for space heating. It has the potential to provide very broad based benefit since space heating is provided in virtually all residential housing and much of it is provided by natural gas combustion. Researchers at several National Laboratories and many Universities have developed and continue to develop meso, micro, and nano scale energy conversion technologies. The potential exists to collaborate with these institutions to further develop those technologies for practical application in larger scale systems which provides a return on prior public investment. Successful demonstration of such systems will attract the attention of traditional suppliers of HVAC equipment as likely co-funders and commercialization partners.

Objectives

The three principle objectives of the initial phase of research to develop a new highly efficient concept in natural gas fired space heating are:

- Estimate the potential efficiency improvement of the new concept relative to the performance of current natural gas fired forced hot air systems in new residential construction. Estimate the potential for reduction in the emission of pollutants and greenhouse gases.
- Assess the feasibility of the concept in terms of compatibility with existing residential construction methods, code compliance, safety, ease of use, and acceptability to end users.
- Estimate capital and installation costs for both new and retrofit construction. Use these estimates along with the efficiency improvement estimate to develop an economic cost-benefit model that can be used to assess the suitability of the concept for different regions of the country.

Subsequent research and development phases must successfully demonstrate key component technologies in laboratory and pre-production prototypes and conduct a complete system level field test of the concept to demonstrate the improvement in energy efficiency, the feasibility of installation, and acceptability to end users.

Budget

2005 : 200000
2006 : 500000
Other : 750000

Comments

It is anticipated that proposed projects would require a 3-4 year development period, including a field test, with the first year dedicated to accomplishing the principal project objectives previously identified. A suitable budget for this first phase is

Project Concept #46: Gas-Fired Recuperative Oxidizer for VOC Destruction

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Description

A wide range of industrial processes produce low-level volatile organic compound (VOC) emissions that are discharged into the atmosphere. These processes range from food processing to metal finishing. Techniques used today to destroy these VOCs before discharge are bulky, costly, and consume large quantities of fuel, often natural gas for combustion. New approaches are needed to reduce the size and cost of VOC reduction equipment and to lower the cost of fuel for this equipment.

Benefits

This technology lowers fuel use for VOC destruction. The technology also provides the means to lower the capital cost of VOC destruction while meeting all California air emissions standards.

Responsiveness to CEC Goals

Overall environmental quality is improved by achieving extremely high levels of VOC destruction on a wide range of industrial processes. New approaches are to be less capital intensive and less energy intensive than existing techniques, so there is both an energy savings and a lower cost of equipment purchase and operation.

Objectives

The objective of this project is to develop and demonstrate a reliable, less costly process for VOC destruction that is extremely energy efficient and thereby consumes significantly less fuel than existing VOC destruction technologies.

Budget

2005 : 333000
2006 : 333000
Other : 333,000
3 year project, total 1,000,000

Comments

Project Concept #47: High Efficiency, Low-NOx Immersion Fluid Heater

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Description

Immersion fluid heaters are used in a variety of California industries, including food processing, metal finishing, chemical and petroleum. A common problem with the immersion heaters is that they may have low fuel efficiencies between 30 and 60 percent. Compared to common boiler technology, these heaters should be able to run at 70 to 80 percent efficiency. Fluid heating represents a major use of natural gas in process heating.

Benefits

Taking into consideration many of the applications, the fire-tube immersion heaters currently waste in excess of 2 to 3 billion BTU/hr of fuel (1360 to 2040 thousand m3/d gas) that could be conserved. This also represents an associated 1.5 million additional tons of carbon dioxide being discharged into the atmosphere each year. Benefits include fuel savings and emissions reductions.

Responsiveness to CEC Goals

Anticipated thermal efficiency increases (up to 70-80 percent) in a wide range of industrial and commercial fire-tube immersed fluid heaters would provide California with energy savings as well as significant pollutant emissions reduction.

Objectives

The objective of this project is to develop and prove the advanced concepts for cost-effective immersion heater efficiency improvements, which would be suitable for both retrofit and new installations.

Budget

2005 : 350000
2006 : 350000
Other : 700,000 total

Comments

Project Concept #48: Development and Field Trial of Advanced Indirect Heating System

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Description

The application of advanced indirect process heating systems will provide substantial energy, environmental and economic benefits to California. For example, conventional gas-fired radiant tubes are used in industrial heat treating applications in which ferrous and non-ferrous materials are processed under relatively high temperatures and reactive atmospheres. NOx levels are high and improved recuperators are needed for high energy eficiency and air preheat temperatures. Also, these tubes can fail in less than 10 months due to creep, thermal shock, carburization, melt-through, and oxidation.

Benefits

Development of a low-NOx system with lower inner tube temperature and a 10 percent increase in thermal efficiency will yield a radiant tube/burner system with longevity that will have applicability in heat treating furnaces in the ferrous and non-ferrous industries wherever moderate to high temperature indirect-fired processing is required.

Responsiveness to CEC Goals

The optimization of indirect heating and the following field trial (with commercial deployment to follow) will result in substantial fuel savings, improved product quality, and reduced air emissions, all with lower operating costs. The combination of these effects satifies all three criteria of the Program: it advances existing fired radiant tube technology; the research benefits will accrue to California ratepayers; and this research is not being adequately addressed by the California heat treating industry.

Objectives

The key objectives of this project are: to increase thermal efficiency by 10 percent or more, which will result in conservation of fuel and lower operating costs. Additionally, NOx will be reduced to <100ppmv compared to 200 ppm for conventional systems; and reduce the temperature difference between the inner and outer tube to <100 degrees F, which improves the longevity of the burner, lowers replacement costs, and lowers NOx formation.

Budget

2005 : 250000
2006 : 250000
Other : 500,000 total

Comments

Project Concept #49: Bio-Gas Fuel Standards for Distributed Generation

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Description

The emissions and performance impacts of operating large (0.5-5.0 MW) engines and turbines with bio-gas fuels are unknown. Gaseous fuels derived from plant or wood feedstocks are comprised of a wide range of compounds, depending on the process and the specific batch of feedstock used. At the same time, engines and turbines used for DG have specifications regarding the fuel gas quality that must be provided to the equipment in order to meet emissions, power, operability and efficiency guarantees. These two issues will need to be resolved.

Benefits

Bio-gas fuels used for DG will displace like amounts of natural gas, on a BTU basis. This cannot be quantified at this time due to limited use of bio-gas, but a market penetration study should be conducted during the research program. Engine emissions will necessarily comply with existing regulations. Quantities of solid wastes associated with production of bio-gas should be less than the feedstock, and may have alternative uses.

Responsiveness to CEC Goals

Six (6) Actions are described in the CPUC Criteria. Action V, "Promote Customer and Utility Owned Distributed Generation" includes a list of seven (7) criteria. This project concept meets at least two (2) criteria: V.1, "Promote clean, small generation resources located at load centers" and V.4, "Develop standards so that renewable distributed generation may participate in the Renewable Portfolio Standard program".

Objectives

A standard for engine performance that accomodates the expected range of bio-gas fuels that also ensures compliance with the acceptability criteria for available equipment.

Budget

2005 : 250000
2006 : 450000
Other : 800000

Comments

Project Concept #50: ORNL HOT WATER DISTRIBUTION MODEL VALIDATION AND ENHANCEMENT

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Description

The second major energy use in homes, following space conditioning, is hot water consumption. For a temperate climate, such as California, this fraction is ~27% of residential energy use. While progress has been made to increase the efficiency of water heaters, little has been done to improve the distribution system. An ORNL analysis for CEC completed in 2004 indicated that the cost of energy and water waste in the distribution system can be as high as 50% of the total domestic hot water cost.

ORNL has developed a simulation model for residential hot water distribution systems. The ORNL-HWD model computes data that can be used in sizing, insulating and placement of hot water distribution systems. Comparing the output of this model with the limited experimental data provided by the Commission indicates an excellent agreement. The objective of this project is to further validate and refine the ORNL-HWD model to enable it to make accurate systematic estimates of energy savings for various hot water distribution systems. Currently no validated numerical simulation model for hot water distribution systems is available. This project will allow efforts to improve hot water distribution system efficiency to be based on validated numerical data.

Benefits

The validated and enhanced model described above will permit the decision makers in the homebuilding industry to understand and optimize the energy and water performance along with customer satisfaction factors of various alternative hot water systems and options. Concurrent with this analysis the model will provide both construction costs and utility cost savings associate with each alternative. Having easy access to this capability should revolutionize the decision making process resulting is significant gains in the performance of these systems.

Responsiveness to CEC Goals

This project focuses on energy efficiency, conservation and environmental issues associated with residential hot water distribution.

It supports State Energy policy by enabling efficient, cost-effective systems to be developed and installed in California homes.

It offers a reasonable probability of providing benefits to the general public by making a tool easily available that will enable those responsible to the design and construction of new homes to make prudent choices that both improve system efficiency and homeowner satisfaction.

Opportunities for collaboration and co-funding opportunities with other entities include the DOE, California utilities and water suppliers, California homebuilders and plumbing contractors, and others.

Objectives

ORNL-HWD modeling verification and upgrades task involves performing data comparison of experimental data to that of the model, fine-tuning the model, and expanding the model to a broader range of system operating conditions. The model will be extended to allow for analysis of very low flow conditions which are being mandated in some parts of the country and it will be extended to analyze developing flow situations, which are applicable to segments with short lengths. These model augmentations will be validated concurrently using experimental data.

User-friendly modifications/improvements task consists of improving the simulation continuity and functionality (including cosmetic improvements). Continuity of operation between simulations will allow the user to start a subsequent simulation without terminating the application and then restarting the model, and will maintain the data from previous selected input file data. Additional functionality will be

incorporated. Functionality and continuity improvements to the model are achievable and will aid in making the model more easily accessible by all potential users.

Capability refinement will include adding the capability of receiving graphical system layout data as input and use it to simultaneously compute the thermal losses of the system and provide an economic analysis of its performance.

A web-compatible HWD model format will be provided for direct user operation through an ORNL web site.

Budget

2005 : 450,000 to 500,000
2006 : 0
Other : 60,000 to 75,000

Comments

Project Concept #51: Impingement Heating of Metals

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Description

Metal heating is typically performed at high temperatures in industrial furnaces that rely on re-radiation of energy from refractory walls to heat the load. Flame impingement provides direct heating of product and allows smaller and more energy efficient furnace construction. Flame impingement provides low NOx performance due to rapid flame quenching on metal surfaces during heating, and improved heat transfer rates for high fuel efficiency. Proof-of-concept is needed in California's metal industsries.

Benefits

Development and deployment of a low NOx metal heating technology (application dependent) will provide benefits to California's ferrous and non-ferrous metal industries. The technology can be applied to heating alloy stainless steels, aluminum, brass, and aerospace materials processed in California. The technology can provide faster heating and reduced furnace cost through high heat transfer and direct heating.

Responsiveness to CEC Goals

Industrial sites are not equipped to carry out R&D that addresses the criteron of energy efficiency, conservation and environmental issues. Although energy conservation by industrial sites will be carried out to some extent, new technologies that replace or more efficiently augment operations will require sponsored R&D such as this direct flame impinegment heating for metals proposal.

Objectives

The key objectives are to develop a metal heating technology that consumes natural gas fuel more efficiently and decreases NOx emissions to conform with the rigorous NOx standards adopted in California. The project will also keep first costs lower than radiation heating or electric induction heating furnaces.

Budget

2005 : 350000
2006 : 450000
Other : 800,000 total

Comments

Project Concept #52: Advanced Reciprocating Internal Combustion Engine Systems - continued RD&D

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Description

Ultra-efficient and ultra-clean reciprocating engines for distributed generation. We need to continue the ARICE program initiated by CEC in 2001 per RFP #500-01-502. Many of the technologies needed to achieve the cost, performance and emissions targets have not been adequately researched, demonstrated or commercialized. These technologies include, but are not limited to: laser-spark ignition, non-thermal plasma exhaust aftertreatment, Homogeneous Charge Compression Ignition (HCCI).

Benefits

Same as the objectives for 500-01-502: 1) a cost of electricity that is competitive with grid-supplied electrical energy, 2) Low adverse environmental impact, especially low atmospheric emissions, 3) High reliability, availability, maintainability, durability, and usability, 4) Market connection.

Responsiveness to CEC Goals

Six (6) actions are described in the CPUC Criteria. Action V, "Promote Customer and Utility Owned Distributed Generation" includes a list of seven (7) criteria. This project concept meets at least two (2) of these criteria: V.1, "Promote clean, small generation resources located at load centers" and V.3, "Determine system benefits of distributed generation and related costs".

Objectives

Advanced engine systems that comply with the 2010 targets: 50% BTE, 0.01 gm NOx, $600 kW, 95% availability.

Budget

2005 : 400000
2006 : 950000
Other : 1500000

Comments

Project Concept #53: Development of an Advanced Aluminum Melting Furnace

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Description

An opportunity exists to substantially improve the design of future aluminum foundry and secondary (scrap) meting technology through the development and application of high temperature, corrosion-resistant heating systems that separate products of combustion from the metal surface while maintaining acceptable heat transfer rates. The development would have the potential to greatly improve efficiency and reduce air and particulate emissions through separation of products of combustion and the molten aluminum while providing improved metal quality and yield.

Benefits

The indirect-fired aluminum melting furnace is seen as a replacement for low-efficiency, direct-fired re-melters and electrically heated re-melters in the aluminum industry. Advantages of this advanced melting furnace include: furnace thermal efficiency of 45-50 percent compared to the current 20-30 percent; significantly reduced emissions (<100 ppmv NOx); dross generation reduced by 20-30 percent; increased production rates; lower exhaust gas clean-up costs; reduced capital costs (estimated at 20 percent); and lower operating costs.

Responsiveness to CEC Goals

The future of this novel aluminum melting furnace would result in substantiial fuel savings, increased productivity, improved product quality, reduced dross generation, conservation of furnace refractory, and reduced air emissions, all with lower capital and operating costs. The combination of these effects advances technology, allows benefits to accrue to California ratepayers, and focuses on research not being adequately addressed by the Claifornia aluminum industry.

Objectives

The key objectives of this project are to devevelop an advanced aluminum melter that consumes natural gas more efficiently and decreases NOx emissions to conform to California standards, while providing lower dross formation and higher product quality.

Budget

2005 : 400000
2006 : 425000
Other : 650,000
(year 3)
total of 1,475,000

Comments

Project Concept #54: Distributed Generation Process Integration

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Description

The opportunity exists to integrate advanced engine and microturbine technology in industrial processes. Waste natural gas flue products can be used for process heating, cooling or electrical generation. Integration of these systems can allow redesign of processes as most thermal processing treatments include heating and cooling cycles. Currently the problem is approached from the engine manufacturer or microturbine manufacturer perspective. What is needed is a process engineering approach to effective integration of DG systems into new advanced plant production facilities. A study and initial set of field trials is being proposed.

Benefits

The benefits are increased overall energy efficiency, new generation capability, and increased economic competitiveness for the industrial sector.

Responsiveness to CEC Goals

The project promotes customer-owned distributed generation and uses waste fuel for electrical production.

Objectives

The key objectives are to identify new process heating configurations that integrate DG technology with emphasis on facilities with combined electric and natural gas process heating demand, and develop integration facility designs and identify an industrial test site.

Budget

2005 : 600000
2006 : 1000000
Other : 1600000

Comments

Project Concept #55: Thermal Solar Generation

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Description

Solar Energy Production Corporation (SEPCOR) proposes to build low cost thermal solar generation power plants using off-the-shelf, mass produced components and simple technology to be the low cost producer of renewable solar power. Natural gas is used as a supplemental heat source to match wholesale and retail load shifting requirements.

The solution for obtaining low cost solar energy is by utilizing existing simple, straightforward and unpretentious technology. The new approach is to seek the lowest cost heat-power devices and equipment of proved capability, and assemble these into complete power systems which yield low cost power, even though at low efficiency. The key to this achievement is the recognition that low-cost can come only with mass manufacturing, thus the system of interest here is based on the use of equipment with a proven history of mass manufacturing success.

The system consists of the following: Standard, mass-produced turbine or vane type motor expanders, which are driven by a low-temperature (typically, 100-200 F) fluid cycle. This fluid cycle heats water by the sunshine falling on collectors that have been constructed using efficient low cost material. The heated water is then stored it in a low cost reservoir. Natural gas is used to supplement low heat times and load shifting requirements by use of a boiler to heat the working fluid to the required temperature. The hot water in the reservoir heats a working fluid to a pressure that activates the expander. After the working fluid has expanded in the engine, it is cooled using standard heat rejection components for use in a process heat application. The working fluid is then returned to the reservoir. The use of water storage for heat allows for control and flexibility in operation of the unit with respect to time of day

Benefits

SEPCOR is a California based corporation. With this support we will directly employ ten full time employees in the development and construction of this 1 MW solar project. Upon successful demonstration of the project the company can obtain equity investments and employ up to 100 manufacturing personnel.

Responding to the California initiative for additional renewable power, most of the initial projects will be located in the regions of California where congestion has been identified. This will assist the ISO in reducing power shortage situations.

This project will demonstrate that rate payers are not economically disadvantaged by renewable energy.

This project provides environmental benefits as it is solar driven. This 1 MW system will eliminate

- 1.8 million pounds of CO2
- 5,400 lbs of NOX
- 400 lbs of SO4

Responsiveness to CEC Goals

This project will demonstrate that by utilizing existing technology, mass-produced components and cost driven development, a thermal solar system can be developed that will be competitive with conventional power plants and that the California rate payers will not have to suffer for clean renewable electrical power.

Energy efficiency is enhanced firstly by use the power of the sun to produce electrical power by creating low pressure vapor to run an engine/generator. Cooling the vapor will involve a true cogeneration process where domestic water can be used to cool the vapor and in the process pre-heated for process applications. This project will demonstrate that for retail applications a true renewable cogeneration technology does exist.

The success of this system will enable the utility companies to meet their mandated requirements by purchasing renewable power at competitive prices. SEPCOR plans to build power generation plants in the size range of 25MW and larger to service the wholesale market. It also plans to build power generation plants in the 100kW to 1 MW range to service the commercial retail market.

Objectives

SEPCOR has built a 100 watt demonstration unit that shows that working fluid pressurized by sunlight can operate a motor expander. The proposal that SEPCOR will submit will request funds to develop a full production 1 MW demonstration plant.

Project objectives are to:

- Demonstrate that solar power generating plants can be built that are competitive with conventional fossil plants.
- Demonstrate manufacturability and cost effectiveness of building the proposed system.
- Demonstrate efficiency versus cost trade-offs.
- Collect operating data from the demonstration power plant.
- Generate revenues from the host site to cover long term O&M costs.

Budget

2005 : 2000000
2006 : 0
Other : 0

Comments

The total cost for a 1 MW thermal solar generation system developed by SEPCOR will be $3.4 million. SEPCOR will co-fund and provide $1.4 million from internal sources and is seeking $2.0 million from the Natural Gas Research Program.

The project will be

Project Concept #56: Man-Made Compressed Natural Gas Storage for Power Plants

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Description

Some of the power generation facilities are electric peaking plants with little or no firm pipeline capacity. Some of them are base load plants that typically run at full power for 16 hours per day and therefore the owners hesitate to purchase full requirement firm gas capacity. In many cases, firm pipeline capacity is not even available. Moost regions of the US, lack the geological characteristics for reservoir, salt or sandstone storage. Local siting may prohibit the development of LNG storage at some locations as well. No such restrictions exist for man-made underground storage. MCP and Northstar have been conceptualizing the need and discussing solutions with customers for man-made, high deliverability, high presuure steel pipe storage at power sites with gas and power customers for the past 24 months. These customers want this concept developed for serious consideration.

Benefits

A significant number of potential sites exist in CA where this concept could be imlemneted for the benefit of the CA rate payers and the environment. The actual number of such potential sites and the quantification of the benefits will require considerable effort and analysis. MCP's extensive experience in the area of market sizing, segmentation, site selection and permitting will help in quantifying theses benefits at the appropriate time. It is anticipated that these benefits are on a large scale.

Responsiveness to CEC Goals

By providing gas where needed, electricity can be generated closer to its point of use. This saves not only on the line losses but also adds to the generation the additional electricity from the pressure let down for the gas. These are both huge savings in energy and creates benefits for the envirоinment due to reduced waste in electricity from both line losses and extra generation.

Since many of the technologies required are already patented by Northstar and the Company's extensive experience the success of the project is highly likely and the risk is minimal.

Objectives

Manmade 50,000 MSCFD storage fields at power generation sites offer an alternative to pipeline capacity for locations in CA State that do not have the geological characteristics for underground storage or for locations where siting of LNG facilities will be hampered by local zoning or by restrictions such as airport exclusions. Several customers have expressed great interest in this concept and desire a more developed model to pursue a complete development of the storage concept. The solution permits a low cost, low environmental impact, highly reliable and redundant supply of gas. It is fdurther envisioned that the 3000 PSIG high pressure withdrawal and pressure let down to 500 PSIG can generate 3 MW of electricity for the site, utilizzing turbo-expander technology, further increasing the efficiency of the transaction.

Budget

2005 : 1250000
2006 : 750000
Other :

Comments

The concept has been prepared for a 1000' by 1000' site for 30,000 to 50,000 MSCF of 3000 PSIG storage. These items will be made available to you at a later date. The 3 MW of power generation from the pressure let down is in itself a substantial contribu

Project Concept #57: High Efficiency Industrial Ovens

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Description

Industrial ovens provide good temperature uniformity (product quality) and process flexibility. They operate above ambient air temperature to about 1400 degrees F, often in temperature-sensitive processes. However, industrial ovens move large volumes of air to transfer heat to the product, resulting in low overall energy efficiency. Curing, drying, forming, or annealing in painting, coating, metal finishing, food processing, agriculture, metals heat treating and other processes can be made more energy efficient through development of a new generation of ovens that reduce air volume demands or use low grade supplemental heat from other processes. A program is needed to develop the next generation of energy efficient industrial ovens.

Benefits

The benefits of a high efficiency industrial oven include lower energy costs (10%) for California ratepayers, increased overall energy efficiency (25%), and reduction in air emissions (10%)

Responsiveness to CEC Goals

Manufacturers cannot provide adequate funding for long duration technology development activities, and often prefer to sell existing engineered systems than initiate radical changes focused on energy efficiency.

Objectives

The key objective is to develop a high efficiency industrial oven that meets California environmental standards, with acceptable first cost, and 25-50 percent improvement in overall energy efficiency.

Budget

2005 : 450000
2006 : 450000
Other : 450,000
(3-year project) total 1,350,000

Comments

Project Concept #58: Combustion Technology Improvements

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Description

Flame stability, flame sensors, burner turndown, flame chemistry control, combustion components, heat transfer improvements, and combustion flow controls and sensor developments are key to providing crosscutting advantages to all industrial segments. An exploratory science and bench scale technology proving program is proposed to develop improvements and to work with manufacturers and end users.

Benefits

Combustion R&D focused directly on California ratepayers as it relates to the need to use mixed fuels will reduce energy consumption, improve environmental performance and help business competitiveness. Benefits are not quanfitiable at this time because this proposal is a "technology proving program".

Responsiveness to CEC Goals

Early stage technology development is perceived as risky and external support is needed to address technical risks and lead pre-competitive technology development.

Objectives

The objectives of this project are development of crosscutting technology that will reduce NOx in targeted application, allow use of mixed fuels, allow use and production of hydrogen, and improve efficiency, productivity and product quality.

Budget

2005 : 800000
2006 : 800000
Other : 1,600,000 total

Comments

Project Concept #59: Thermal Efficiency Improvement of Radiant Sections in Fired Heaters and Process Boilers

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Description

Fluid heating is a major use of natural gas energy in a variety of applications in petroleum, chemicals, metals and food processing. Heat is provided to the process fluid mostly by radiation and convection. Heat distribution in a typical fired heater is broken down as follows (approximately): radiant section - 60%; convective section - 25%; losses - 15%. Process heaters are used in California's petrochemical industry and can obtain energy savings by enhancing either of the heat transfer mechanisms (convection or radiation).

Benefits

Energy savings and improved emissions realized by development of this technology would accrue to the ratepayers of California.

Responsiveness to CEC Goals

Anticipated efficiency improvements would provide California industry with up to 25 percent energy savings, as well as improved combustion emissions in process heaters.

Objectives

The primary objective of this project is to develop and prove that enhanced heat transfer tube surfaces in fired process heaters and boilers can provide significant thermal efficiencies and energy savings.

Budget

2005 : 350000
2006 : 350000
Other : 700,000 total

Comments

Project Concept #60: Synergistic Efficiency and Environmental Enhancements for Industrial Heating Systems

Robert K. Cheng David Littlejohn
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Description

California has the most stringent environmental rules for industrial stationary sources. Meeting these tough emissions targets has been a costly compromise to system efficiency. But with a new generation of ultra-clean and very cost-effective combustion concepts, there is a great opportunity to develop synergistic approaches that can reverse this trend from efficiency losses to efficiency gains. Our plan is to develop and demonstrate synergistic efficiency and emission enhancement methods for low (up to 1250F) and medium (1250F to 1800F) heat processes. They are most prevalent in California's chemical production industries and manufacturing industries that require heat treating, drying and baking and represent a large portion of the industrial natural gas utilization (970 Mth total in 2002). Our enabling technology is an ultra-clean combustion process that has recently been commercialized for small industrial direct fired heating systems (up to 6 Mbh). Its robust and highly adaptable design is ripe for optimization for systems (up to 30 Mbh) to improve load following and excess air. Accomplishing these combustion goals alone will improve system efficiency by 2 to 4%. In addition, the operational flexibility offered by this concept (compared to much more restrictive operational envelope of other low emission combustion concepts) can be further exploited to optimize heat transfer to the load and heat losses for an additional 5 - 25% efficiency gain depending on the process. Due to the diversity of industrial systems, the R&D work will involve laboratory experiments and computational studies to develop and evaluate the synergistic approaches. These concepts will be demonstrated at full and reduced scale low temperature and medium temperature systems in partnership with combustion equipment manufactures and end users.

Benefits

Depending on the heating system, implementation of our synergistic scheme is expected to increase system efficiency from 5 to 25% and save an estimated 50 Mth per year. NOx will be lowered from current average levels of 50 ppm to less than 9 ppm to reduce 1000 tons of NOx emissions per year. (Both estimations based on 400 Mth per year usage for the targeted industrial processes). Cost-effective low emission systems that are more energy efficient than their current counterparts will help Ca industries stay competitive.

Responsiveness to CEC Goals

This research is consistent with the CPUC critera of "public interest" in that it will benefit the California public by increasing the efficiency of natural gas use in a significant market sector and by reducing pollutant emissions. Developing the guidelines and engineering rules for synergistic efficiency and emission advancement methods requires the understanding and synthesis of fundamental scientific knowledge on burner technology, combustion chemistry, combustion fluid mechanics, heat transfer, in chamber fluid motions and fluid properties of the process fluids. This is a scientific system development approach targeting a broad range of industrial processes. It is fundamentally different than the product development approach taken by competitive market R&D.

Objectives

The deliverables are a set of proven design guidelines and engineering rules that can be readily applied to build new ultra-clean industrial heating systems or upgrade existing industrial systems to increase their system efficiencies as well as meeting California's air quality rules. The metrics are $5 < NOx < 9$ ppm throughout the system load range, no more than 3% excess O2 for combustion, at least a 5:1 turndown ratio and cost effectiveness comparable to current high NOx systems. The main targeted application areas are fluid heaters, drying, and heat treating. Currently, these processes have very low system efficiencies of 15 to 85% and the potential to increase efficiency and save energy is significant.

Budget

2005 : 300000
2006 : 300000
Other : 200000

Comments

Project Concept #61: Residential-Small Commercial Superboiler Development

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Description

The GTI and a major boiler manufacturer have been working on an innovative package boiler system that combines ultra-high fuel efficiency with ultra-low emissions and a very compact design for steam boilers greater than 2 million BTU per hour. The performance target is 94 percent fuel-to-steam efficiency, with NOx and CO below 5 ppmv and a 50 percent smaller footprint than conventional boilers. To date, NOx has been reduced as low as 3 ppmv while maintaining CO below 10 ppmv across the firing range. Exess air is maintained at 3 percent or lower for improved efficiency compared to low-NOx burners that use flue gs recirculation or high excess air. For improved heat transfer, the boiler uses advanced firetubes with extended surfaces that help achieve a compact design, reducing size, weight, and footprint. The advanced heat recovery system combines compact economizers, a humidifying air heater, and a patented transport membrane (TM) condenser.

The project would extend superboiler technology to both steam and hot water boilers below 2 million BTU per hour.

Benefits

The benefits of this project include energy savings, space savings due to smaller footprint, and emissions reductions. If achieved, it is believed that the high efficiency boiler market share would expand application and use and increase market share of high efficiency boilers from the current two percent to over 25 percent. The technology will find its way in residential and commercial establishments, and in a variety of applications from space heating and cooling, mini-district heating and cooling, and commercial processes.

Responsiveness to CEC Goals

This research benefits the public interest by allowing energy savings to accrue to California ratepayers.

Objectives

Incorporating superboiler technology to boilers less than the 2 million BTU size range requires that cost of manufacturing be a primary consideration. In the initial feasibility stage, acceptable manufacturing cost targets would be set with the participating boiler manufacturer. In addition, a minimum efficiency of 94 percent, with an emissions target of 5 ppmv and a reduction in boiler footprint and weight, would be validated. If achieved, it is believed that the high efficiency boiler market share would expand from the current two percent to over 25 percent.

Budget

2005 : 500000
2006 : 500000
Other : 500,000
per year for 2007 and 2008
4 years, total
2,000,000

Comments

The gas LDCs will support this R&D

Project Concept #62: Ultra-Clean Residential and Commercial Space Heaters

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Description

Commercial and residential space heating in California consumed about 430 Mth of natural gas in 2002. While many current higher-end models have relatively good efficiencies, their emissions of NOx remain unsatisfactory (about 150 ppm) compared to the levels achievable in larger industrial systems (15 – 30 ppm). This is because the advanced combustion technologies developed for the larger systems are not sufficiently cost effective for these commercial and residential heaters that are essentially commodity products. However, two ultra-clean burners developed at the Lawrence Berkeley National Laboratory can be very cost effective solutions to lower the emissions of these space heaters. Both are robust, simple, and amenable to mass production from conventional materials. In laboratory studies, these burners have been shown to emit less than 9 ppm NOx and 20 ppm CO, and can also improve overall efficiencies. One of the designs (the low-swirl burner) is already in production for direct fired process heaters. The other (the ring-stabilizer) had produced excellent results in a laboratory furnace. The focus of the R&D work will be to adapt these designs to forced air furnaces up to 1 MMBtu/hr and duct heaters up to 3 MMBtu/hr. Due to the large variations in the size and geometry of the heat exchangers in space heaters, our strategy is to develop the design guidelines and engineering rules to help equipment manufacturers to adapt these burners to fulfill their specific requirements. We plan to partner with several OEMs of space heating equipment to develop, evaluate and demonstrate these burners in representative systems. Knowledge gained from these developments will be encapsulated in the guidelines and rules for adaptation to other systems and mass production methods.

Benefits

Depending on the heating system, implementation of these burners to residential and commercial space heaters are expected to reduce the emission of NOx from 150 ppm to 15 ppm and increase system efficiency by 1 to 3 %. This will help to reduce 3000 tons of NOx emissions per year. (Estimation based on 430 Mth per year usage in California for the targeted space heaters).

Responsiveness to CEC Goals

This research is consistent with the CPUC critera of "public interest" in that it will benefit the California public by reducing pollutant emissions and by increasing the efficiency of natural gas use in a significant market sector. Developing the guidelines and engineering rules for a variety of residential and commercial space heaters requires the understanding and synthesis of fundamental scientific knowledge on burner technology, combustion chemistry, combustion fluid mechanics, heat transfer, in chamber fluid motions and fluid properties of the process fluids. This is a scientific system development and manufacturing approach targeting a broad range of systems. It is fundamentally different than the product development approach taken by competitive market R&D.

Objectives

The deliverables are proven burner design guidelines and engineering rules for adaptation and manufacturing of low-swirl burners and ring-stabilizer burners for forced air heaters and direct and indirect duct heaters. The metrics are 9 < NOx < 15 ppm, manufacturing cost not to exceed 20% of current products, operating cost same as current products, utilize existing controls, and improve efficiency by 1 to 3 % from current system baselines.

Budget 2005 **:** 200000 2006 : 200000
Comments none

Project Concept #63: Efficient Landfill Gas Utilization for Electricity Generation

Savvas Vasileiadis, Ph.D. Zoe Vasileiadis, Ph.D.
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Description

Landfill gas coming out of variable size landfills is an important source of energy, especially for generation of power in gas turbines and gas engines. This project will utilize landfill gas in an efficient way to produce electricity. The project will focus on improving the fuel efficiency of the landfill gas. Several attempts will be made to increase the quality of the landfill gas by means of partial conversion of the gas into a hydrogen mixture.

The conversion can be achieved by various means, but preference will be given in catalytic conversion reactions

to yield a hydrogen mixture.

Subsequent use of the mixture in gas turbines will increase the fuel quality and the improved characteristics of combustion. Simultaneously, the emissions of pollutants including nitric oxides will be substantially reduced at the exit.

The landfill gas mixtures constitute for renewable fuels and use of the proposed technology will improve their wider use for efficient electricity conversion.

Benefits

- Increase utilization of Landfill gases coming out of landfills and solid waste accumulation sites for conversion into electricity. Expected increase in the efficiency of the generator of about 10-14%.
- Increase utilization of the Landfill gases by m

Responsiveness to CEC Goals

Objectives

Budget

2005 : 70000
2006 : 70000
Other : 70,000
for 2007

Comments

Project Concept #64: Multimixture Natural Gas Clean-Up Technology for Effective Generation of Electricity

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Description

Natural gas (NG) coming out from various sources contains significant quantities of several additive, non-value components.

These include mainly gas-phase components which need to be removed before the NG is used in turbines and engines for elect

Benefits

- Increased utilization of multimixture natural gases for conversion into electricity. Expected increase in the efficiency of the generator of about 15-30%.
- Increased utilization of multimixture natural gases by means of separation and clean-up techn

Responsiveness to CEC Goals

Objectives

Budget

2005 : 78000
2006 : 78000
Other :

Comments

Please, contact us if you need further details on the two projects/proposals submitted on Sept., 29, 2004 for the State's gas research and development program.

Thank you.
Sincerely,
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Project Concept #65: Thermal Distribution Systems

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Description

Energy losses from thermal distribution systems waste roughly 20 to 25% of the gas used to heat California homes. To achieve any significant reductions in this waste, we need to focus on existing construction and how it can be retrofitted in a non-cost-prohibitive way. Packages of retrofit technologies will be developed that are tailored to California homes and climates, together with a set of diagnostics that will guide the selection of the most appropriate technologies.

In new construction, the focus will be on the evaluation of promising technogies that are currently under-utilized (e.g., hydronic fan-coils) and integrated HVAC systems that will minimize the use of gas for conditioning ventilation air. Because the equipment and design concepts already exist that can provide the high efficiencies we are seeking, this work concentrates on proof-of-concept and integration issues.

Benefits

Total residential gas consumption used to heat residences using ducts is about 1600 million therms. Typical savings measured in field studies by LBNL and calculated using ASHRAE 152 are about 20%. If all existing houses were retrofitted it would result in a saving of 312 million therms.

For new construction, the gas savings cvan be broken down for a typical house that uses about 180 therms for heating. Duct sealing could save about 18 therms per year and if ducts are moved into conditioned space, the savings are 49 therms per year.

In addition to saving gas, and the associated reductions in combustion products being emiitted, the improved thermal distribution systems also provide greater comfort for occupants. When we also integrate proper ventilation there are additional benfits of reduced indoor pollutant levels that can bring significant health benfits.

Responsiveness to CEC Goals

This project will result in increased HVAC system efficiencies that will lead to about a 20% reduction in gas consumption and the associated reduced emmissions of combustion products.

The focus is on technologies and concepts that can be implemented rapidly and so it will provide immediate benfits to the general public.

The work proposed here is not being done by the indsutry. The highly fragmented nature of the building HVAC industry means that coordinating efforts like those proposed here will not be taken on by the industry.

There is an opportunity for co-finding with the US DOE who are developing similar retrofit package concepts and have a history of supporting diagnostic tool development for thermal distribution systems. The project would also coordinate with the efforts of Building America teams who are working on integrated HVAC systems and minimizing thermal distribution system losses in new construction. There is also the possibility of collaboration with individual entities who have experience in particular fields, e.g., Davis Energy Group, who have worked on fan-coil systems as an alternative to gas furnaces.

Objectives

Packages of retrofit technolgies that result in optimum efficiency for gas heating systems.

Guidelines for selection of different packages that will depend on the existing home and HVAC system condition, as well as local climate.

Proof of concept for one for more promising technologies and integrated HVAC systems for reducing gas use that can be used in existing or new construction.

Budget

2005 : 400000
2006 : 350000
Other : 100000

Comments

This project will be performed in parallel with DOE efforts that have similar goals and objectives. This leveraging will approximately double the funding and effort available.

Project Concept #66: Aerosol Sealing of Gas Pipelines

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Description

LBNL has developed an aerosol sealant technology for use in air ducts, but it could in principle be used to seal natural gas pipelines. Losses from leaky pipelines are estimated at 7% and represent both an energy waste and an increase in greenhouse gas production. This project would adapt the aersol sealant technolgoy for use in gas pipelines.

The aerosol technology has the ability to remotely seal leaks that are otherwise diffcult to access in pipelines. The main issues to be faced are split into three groups:

Chemical - reactions between natural gas and the material used as a sealant - this may effect durability of the seal.

Sealant particle aerodynamics - in sealing duct systems we rely on a flow or air out through the leaks to transport the sealant particles to the leak. The aerodynamics of this flow need to be optimized for buried pipes.

Compatibility with pipeline controls - does the selant affect the valves and other controls?

Benefits

Reduce greenhouse gas emission by directly avoiding leakage of natural gas into the atmosphere.

Reduce losses of natural gas that must be paid for by end-user. This could be as high as 7% of the natural gas consumed in the state: 350 million therms for residential customers alone.

This work will benefit from collaboration with gas utilities who are the most likely end-users of the technology.

Responsiveness to CEC Goals

This project develops a new technology that can be used throughout the stae and possiblke exported to other states.

The reduction in gas pipeline leakage would improve global climate and reduce consumption of natural gas paid for by CA ratepayers.

This application of aerosol sealant technology is not being pursued by competitive or regulated industries.

Objectives

Demonstrate feasibility of sealing natural gas pipelines using aersol sealant technology. This would require developing an aerosol sealer that is optimized for sealing pipelines. A prototype device will be constructed, and evaluated and demonstrated on buried gas pipelines. This technology could then be used by private industry (most likely utilities) as the basis of a state-wide gas pipe-sealing initiative.

Budget

2005 : 450000
2006 : 350000
Other : 200000

Comments

This project will be coordinated with state gas utilities who can provide vital input on issues such as specific pipe leak characteristics. The utilities could provide the sample pipe-lines used for demonstrations.

Project Concept #67: Near-Condensing Gas Storage Water Heaters: Issues of Policy and Practice

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Description

Low-efficiency storage natural gas water heaters predominate in California. These yield only about 60% net annual efficiency (EF). Although condensing water heaters can do much better, they are inherently much more expensive, and have an inconsequential residential market share.

"Near-condensing water heaters" (NCWH) are promising. Their recovery efficiency can be close to that of condensing water heaters but their costs can be much closer to conventional units, and standby losses can be much lower. The key is to virtually eliminate the standby losses associated with today's units, which rely on gravity venting with a draft hood to eliminate combustion products. The majority of these losses are associated with the lack of a barrier (such as a vent damper) to prevent convective circulation of air that is warmed in the water heater's heat exchanger and then vented out of the system. Because the storage water heater remains hot (unlike furnaces), we anticipate great design flexibility, since there need not be condensate/corrosion issues. There are several promising routes to NCWH; these are the subject of a complementary concept proposal from the Lawrence Berkeley Laboratory.

Even if such a NCWH is built and will be cost-effective, there are many barriers in the path to market acceptance. We believe that rapid market penetration requires fuller understanding, and that this work should be begun in parallel with product development. As a complement to a technical concept proposal, this concept focuses on broader market questions: (1) life-safety code requirements, (2) Title 24 energy code opportunities, (3) opportunities to reduce NOx emissions, (4) opportunities to improve efficiency and reduce construction costs by using higher efficiency water heaters as heat sources for both domestic hot water and space heating, and (5) marketing issues, for builders and consumers.

Benefits

If successful, this project would facilitate the success of a technology that has the potential to reduce water heater NOx emissions by about 20% (from efficiency gains alone). It would also reduce consumer energy costs, and open new opportunities for increased efficiency. This is particularly true if it leads to combined water heating and space heating appliances that are more efficient and lead to lower emissions.

Responsiveness to CEC Goals

"Public interest gas R&D activities are directed towards developing science or technology, 1) the benefits of which [sic] accrue to California citizens and 2) are not adequately addressed by competitive or regulated entities." In addition, they "focus on energy efficiency, renewable technologies, conservation and environmental issues; support State Energy policy; offer a reasonable probability of providing benefits to the general public, and consider opportunities for collaboration and co-funding opportunities with other entities."

The proposed project concept is important for delivering the fruits of technology development and demonstration. Because of the temperate to warm climates prevailing in California, condensing gas appliances are unlikely to be cost-effective, so products that improve energy efficiency and decrease NOx emissions are important, if they can be cost-effective. This project supports State Energy Policy and has a high probability of providing benefits to the general public. We also expect that this would be a collaborative project, because of the diversity of skills required.

Objectives

The project objective is to develop a "friendly" market and policy environment for early market adoption of near-condensing storage water heaters, if cost-effective designs can be demonstrated. Means to accomplish this include:

- Code barriers and opportunities. Different technology options have quite different implications for appliance venting, considered a life-safety issue. One objective is to provide early input on which options are likely to face greater or lesser implementation barriers, to help focus R&D on products with easier adoption paths (all other measures being equal.)
- Analysis of economic and environmental benefits. This includes potential of both free-standing NCWH, and NCWH used as combined heating appliances (including replacements for resistive second stage for air source heat pumps.)
- Market Transformation opportunities. Can we show that the benefits are large enough to justify utility initiatives to rapidly and substantially increase utilization of improved NCWH?
- Ratings as barriers and opportunities. Do existing rating methods appropriately account for stand-by losses? How would one rate an air source heat pump with back-up from the NCWH? As a combined appliance?

Budget

2005 :
2006 :
Other :

Comments

Ideally, a budget of $150,000 - $200,000 over two years could be applied effectively. However, a strong start can be made with a more modest start.

Project Concept #68: Efficiency Optimization of Gas-Fired Heating Systems Using Feedback From Real-Time Sensors

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Description

Much of the natural gas consumed in California is burned to generate heat for industrial, residential, or commercial applications. The burners used in these systems often do not operate at optimum efficiency because of concerns related to pollutant emissions. Heat transfer improves as the exhaust gas temperature is increased. However, increasing the exhaust gas temperature can lead to an increase in emissions. To insure that the emissions do not exceed regulatory limits, manufacturers may set the burner operation point well away from optimum point. This situation can be avoided by developing sensors for the burners that can monitor their operation in real time and provide feedback to the burner control system. Many burners have control systems that can be readily adapted for inputs from sensors. The proposed project will develop low-cost sensors that can be incorporated into the burner assembly and interfaced to the burner controls. The sensors will monitor the relevant flame properties and allow the burner to operate at high efficiency while maintaining emissions within regulatory limits.

Much of the natural gas consumed in the State supplies large burners with control systems. In some cases, these systems may generate significant amounts of air pollutants in spite of burner controls. This issue is particularly important in multi-burner systems. Appropriate sensors could monitor pollutant levels and interact with the burner controls to reduce emissions while obtaining good efficiency.

Benefits

Demand for natural gas has been increasing in recent years because it is generally a cleaner fuel than liquid hydrocarbons. Improving the efficiency of heating systems will ease the pressure on constricted natural gas supplies within California. It is possible that a several percent efficiency improvement in heating systems can be achieved by optimizing burner operation. This will moderate natural gas prices for California consumers. The optimization of process heaters will also reduce industrial emissions of NOx and CO by as much as several hundred tons per year, and will benefit consumers by reducing air pollution levels in California.

Responsiveness to CEC Goals

The proposed research will advance sensor technology for combustion systems. We will build on our experience with sensors and flame diagnostics to develop low-cost designs suitable for real world applications. The project meets the criteria of "public interest" research because it will lead to cleaner, more efficient heating systems in California. It will improve system efficiency in a significant segment of industrial, residential, and commercial gas consumption, and it will reduce the California air pollution burden. In a competitive and regulated market, California industries have limited funding allocated for research. Industrial research support is directed to very short-term programs with immediate payback.

Objectives

One of the key objectives of this proposed project is to develop sensors that will allow higher operating efficiencies in natural gas-fired burner systems used in industrial, residential, and commercial systems in California. The improved operating efficiencies will reduce demand for natural gas and help avoid increases in natural gas prices for California consumers. Another key objective is to reduce pollutant emissions from these facilities. Reduced emissions will improve air quality in California and provide a more healthful environment.

Budget

2005 : 200000 2006 : 200000 Other : 200000

Comments

none

Project Concept #69: Natural Gas Pretreatment for Development of Ultra-Low Emission Gas Turbines

David Littlejohn Robert K. Cheng
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Description

Mid-sized natural gas-fired gas turbines are well-suited for distributed generation and CHP applications in California. The turbine combustors that are currently under development are capable of achieving single digit NOx levels and very low CO emissions. Turbines with these combustors are likely to be commercialized within the next few years. However, in areas of the State where ozone non-attainment is an issue, even these low emission levels may be excessive, and better emission control is needed. One possible technique to achieve near zero emissions from gas turbines is fuel pre-treatment. Modifying the fuel composition will allow turbines to operate with very low pollutant emissions. Preliminary small-scale tests indicate that it should be possible to achieve < 1 ppm NOx and single digit CO emissions by appropriate fuel pretreatment. Such low emission levels would be acceptable in even the most restrictive air districts.

Benefits

The proposed concept has the potential to decrease emissions from power turbines to levels that are less than 5% of current emissions levels, and less than 25% of the emissions levels of the next generation turbine systems. These near zero emissions levels can be achieved with essentially the same efficiency as current systems. Significant energy efficiency improvements can be obtained by incorporating these turbines in CHP systems.

Responsiveness to CEC Goals

The proposed project meets the criteria of "public interest" research because it will develop power turbines with near-zero emissions that will be suitable for distributed generation in all areas of California. When incorporated in CHP systems, these turbines will provide high efficiency and clean power from natural gas for the California public. In the current competitive and regulated market environment, private companies do not have the resources to develop advanced emission control concepts on their own.

Objectives

The key objective of this project is to develop a fuel pretreatment process for gas turbines that will allow operation with near zero emissions while maintaining high engine efficiency and good stability and operating characteristics. Other objectives for the development of a pretreatment process are to achieve system economics that are competitive with post-combustion emission control systems, to have a low operating cost, to have a long intervals between service, and to not significantly increase the system footprint.

Budget

2005 : $300K
2006 : 0
Other : $300K

Comments

Solar Turbines is interested in participating in the development of this concept.

Project Concept #70: Assessment of the Impact of LNG Imports on California Natural Gas Composition and on the Operation o

David Littlejohn Carlo Castaldini
Lawrence Berkeley National Laboratory
David Littlejohn

Description

Several LNG import terminals are being planned for southern California and northern Mexico. The natural gas from these sites has the potential to significantly contribute to California's natural gas supply. However, foreign natural gas standards differ from California natural gas standards. In particular, LNG imports will produce natural gas with higher Btu content than the natural gas currently in use within the State unless gas conditioning is performed at the terminal. The higher Btu content may result in higher NOx emissions when the gas is burned in end-use systems and may affect the stability of gas-fired burners.

We propose to study the impact of the increase in natural gas Btu content on gas-fired burners used in industrial, residential, and commercial systems. We will assess burner emissions (NOx, CO, and UHC) and flame stability, and how they are influenced by natural gas Btu content. Some burner designs may be less susceptible to changes in the Btu content than other models. This information will be used to develop a measure of the impact of natural gas Btu content on air quality in the State.

Benefits

The proposed project would provide information on the impact of an increase in the natural gas Btu content to the State. It would develop an estimate of the changes in air pollutant emissions and would determine if flame stability in end-use gas fired systems would affected by changes in the composition of natural gas.

Responsiveness to CEC Goals

The proposed research is in the public interest because it will identify the impacts of LNG imports though the proposed LNG terminals in southern California and northern Mexico that would be connected to the natural gas distribution system within the State. It will assess air quality impacts associated with an increase in the Btu content of natural gas. This research is not the likely to be supported by the private sector, especially energy companies that compete with one another in the marketplace and are regulated by State and Federal regulations.

Objectives

The key objectives of the proposed study are to determine how variation in natural gas Btu content affects the emissions and flame stability in burners at sites within California that use gas-fired systems for power and heating. The dependence of the burner emissions on Btu content will be assessed and used to develop an estimate of how the air pollution burden in California will be impacted by an increase in natural gas Btu content.

Budget

2005 : 250000
2006 : 250000
Other : 250000

Comments

Project Concept #71: Development of Improved Low-Emission Burners for Natural Gas-Fired Water Heaters and Furnaces for Re

David Littlejohn Robert K. Cheng
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Description

Natural gas-fired water heaters and furnaces that are used in residential and commercial applications are facing increasing scrutiny relating to pollutant emissions. California and Texas currently limit residential water heaters NOx emissions to 40 ng per joule of heat released (as NO2) and are planning to lower the limit to 10 ng per joule. This latter value is equivalent to 15 ppm NOx at 3% oxygen on a dry basis. Other gas-fired systems are likely to face similar restrictions. There is concern that the low emission burners for these systems that will be developed will be excessively expensive and have poor stability and durability. There are simple, robust low-emission burner designs that have been developed for industrial applications that can be adapted to operate in residential and commercial systems. These low NOx burners will be capable of meeting the projected NOx emissions limits for states with ozone non-attainment areas.

Benefits

Adapting low NOx natural gas burners to residential and commercial heating applications will lead to appliances that have NOx emissions with < 25% of current emission levels. This will contribute to lower pollutant loading in air basins susceptible to ozone non-attainment, and improved air quality for the California public. These low NOx burner designs can be adapted to appliances without substantial modification of the systems, so that there will be little increase in product cost to consumers. The systems will have efficiency as good or better than current models.

Responsiveness to CEC Goals

The proposed research will develop efficient, cost-effective low emission burners for appliances sold in California. The research is in the public interest since it will provide consumers with products that have < 25% of the NOx emissions of current systems without large increases in product cost or without limiting choices to consumers (i.e. restricting appliances to electrical heating). The market for residential and commercial gas-fired appliances is competitive, and industries have limited resources for product development. Product emissions are regulated only in some geographical regions, and the market within the regulated areas is not always large enough to drive the development of lower-emission products. As a result, support is needed from the CEC to develop improved low-emission burners for appliances.

Objectives

One of the key objectives of this program are develop gas-fired low NOx burners for water heaters and furnaces for use in residential and commercial applications. The designs will be optimized for reliability, durability, and cost-effectiveness. Manufacturers will be able to utilize these designs to produce low-emission appliances capable of meeting emission criteria in ozone non-attainment areas.

Budget

2005 : 200000
2006 : 200000
Other : 100000

Comments

Project Concept #72: Low Emission Fuel-Flexible Burner for Natural Gas and Fuel Gas from Renewable Resources

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Description

Renewable resources have the potential to make significant contributions to California's energy supply. Fuel derived from plants, crop waste, and other renewable resources can be generated as solid, liquid, or gas. However, the gaseous form may be most straightforward to integrate into the distribution system with in the State. The major constituent of biogas is generally methane, although there are a number of other significant constituents. These include fuel gases such as other hydrocarbon gases, methanol, ethanol, carbon monoxide, and hydrogen, and inerts such as nitrogen, carbon dioxide, and water vapor. Thus, biogas can exhibit significant variability in composition, heat content, and flame speed. A further complication is that biogas generators may have significant seasonal variation in production.

To most effectively utilize biogas resources, burners are needed that can efficiently burn natural gas, biogas, or biogas-natural gas blends. Unfortunately, many burner designs do not have this flexibility. Low emission burners for industrial heating are generally complex systems with a narrow range of operating conditions.

It is desirable to develop burners that can achieve low emissions when fired with a range of gaseous fuels, including natural gas and biogas with low heat content. We have an innovative burner design that has demonstrated low emissions and good flame stability when fueled with a range of gaseous fuels. We believe that this design can be adapted to also operate on biogas or biogas-natural gas blends. This burner has the potential to effectively utilize biogas while maintaining low emissions needed to minimize impact on the State's air pollution burden.

Benefits

Biogas has the potential to contribute up to 5% of the natural gas supply for California. Being a renewable resource, it does not contribute to the atmosphere's carbon dioxide burden the way that fossil fuels do. It will contribute to less dependence on energy producers outside the State. It can be burned as cleanly as natural gas, and its use would not negatively impact air quality.

Responsiveness to CEC Goals

There is currently insufficient demand for fuel-flexible burner that burner companies are unwilling to commit their limited research resources to develop suitable burners. This research would be in the public interest because it will effectively increase the fuel supply within the State and would not negatively impact the State's air quality. The burner manufacturing market is competitive, and emissions from the burners is regulated, especially in the South Coast Air District. These factors have resulted in little research and development on fuel-flexible low-emission burners.

Objectives

The key objectives of the proposed project are to adapt a new burner design for operation on biogas and biogas-natural gas blends, and to determine how the burner flame stability and emissions are influenced by varying the composition of the fuel gas. Another objective is to identify the optimum operating conditions for the burner when fueled with biogas compositions that are typically produced from biogas generation facilities.

Budget

2005 : 200000 2006 : 200000 Other : 200000

Comments

(none)

Project Concept #73: Natural Gas fired Laser for Power Generation

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Description

Design and build a small continuous laser that would be fired by natural gas and would generate electricity at a much higher efficiency that the existing power plants. At first a small one to prove the concept, then larger until a commercial product is achieved. The major loss of efficiency in most power plants is in the steam condenser. The laser power generation plant will use photovoltaic technology to generate power. This will be a brand new power generation cycle.

Benefits

Reduced air pollution, reduced water pollution, lower costs of electricty and natural gas.

Responsiveness to CEC Goals

This will insure long term available power at a very low cost to the people of the state of CA. It will also be worth billions to people around the world when proved and taken to the next step which would be -fueled by coal. This is truly a phenonmenal environmental friendly project.

Objectives

Huge increase in efficiency in power plant operation would decrease California's natural gas consumption and lead to lower utility rates, for both electricity and natural gas.

Budget

2005 : 845000
2006 : 1635000
Other : 4250400

Comments

Project Concept #74: Infiltration and Ventilation Interactions with Gas Appliance Venting

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Description

Combustion products from gas-fired appliances can enter the indoor environment accidentally when venting is insufficient or deliberately in the case of unvented appliances. In either case, product concentrations must be minimized to avoid causing health or comfort problems for building occupants.

Naturally-aspirated vented appliances typically rely on leaks in the building envelope to provide makeup air that supports proper venting to outdoors. Unvented appliances rely upon having a sufficient air change rate indoors to dilute combustion products. Both these venting processes involve air-exchange related energy penalties, which in turn affect the load imposed upon gas appliances used for space heating. When the building envelope is tightened to reduce air infiltration or when mechanical exhaust systems are operated, the airflow assumptions may no longer be valid and inadequate venting or space ventilation may occur. Although there has been substantial work over the past 20 years outside of California in the United States and in Canada to understand the impacts of exhaust system operation on the venting of naturally-aspirated combustion appliances, no such work has been carried out to address California housing and climate characteristics.

Using field studies, this project would determine both the energy and environmental impacts of infiltration and ventilation interactions on vented and unvented gas appliance operation for a wide range of California houses throughout the state. It would also develop simplified diagnostic procedures for use in commissioning and retrofit programs to assess the airflow-appliance interactions, and would produce new guidelines for the safe and efficient operation of these appliances in California homes.

Benefits

The primary benefit of the project would be improved indoor air quality (IAQ). In particular, the direct benefit would be reduced concentrations of combustion products indoors and better occupant health (e.g., reduced exposure to combustion-generated nitrogen dioxide can lead to reduced chronic respiratory problems). Because the project would also address improved ventilation as an integrated strategy for controlling combustion products, indirect IAQ benefits may also result from the reduction of other indoor pollutant concentrations in addition to the direct benefits.

Further benefits could include improved occupant comfort and better energy performance through the provision of data that allow improved choices of equipment.

Responsiveness to CEC Goals

Although there has been substantial commendable activity by the gas industry over the past 100 years to define safe operation guidelines for gas appliances, this industry has not addressed the impacts of infiltration and ventilation system interactions, which occur outside the boundaries of the appliance and its venting system. In part, this inactivity has been due to the multifaceted complexities of the problem and the fragmented nature of building industry itself. It also appears to be a result of no clear evidence that there are problems in California houses (in part due to a lack of diagnostics to identify problems), as well as a concern that addressing such issues is counter-productive to the gas industry: addressing problems beyond the immediate control of the gas industry might impact consumer inclinations to use gas appliances.

The new knowledge embodied in the diagnostics and guidelines developed in this project would be a public good that is uniformly available to all institutions, including manufacturers, contractors, building inspectors, regulators, utilities, and consumers. It would also provide a basis for the further development of related standards by professional organizations such as ASHRAE and ASTM.

Objectives

The most important outcomes will be diagnostic procedures for use in new and existing houses and guidelines on how to effectively use gas appliances in California houses to avoid airflow-related problems. Particular emphasis will be placed on developing diagnostics that can rapidly and reliably identify appropriate metrics such as the cold-vent establishment pressure (CVEP) for naturally-aspirated appliances. The CVEP represents the maximum indoor-outdoor pressure differential against which the hot combustion gases from the appliance can establish a proper flow through the vent. Emphasis will also be placed on defining air-tightness, air change rate, and unbalanced ventilation constraints that enable gas appliances to operate properly while minimizing associated energy penalties.

Budget

2005 : 500000
2006 : 400000
Other : 400000

Comments

Air tightening is limited by the need to provide sufficient ventilation and to avoid creating excessive house depressurization. Part of this project would examine existing ventilation standards to better define these limits and, when necessary, take mecha

Project Concept #75: Development of low emission dual fuel combustor for microturbine generators

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Description

This project will develop a "dual fuel" combustor system for use in microturbine generators (MTG). The ability of the microturbine to operate on a backup fuel will allow gas use to be curtailed in time of general need or high price. It also facilitates use of the MTGs for backup power. While some MTGs today can operate on either natural gas OR liquid fuel or propane, none can operate on both fuels interchangeably. The proposed project will develop and integrate the necessary elements required for both fuels and will provide technology that can be incorporated into a commercial device.

Benefits

The benefit to the public is an overall improvement in the reliability of the energy and thermal generation device. By allowing natural gas to be curtailed in time of need, the customer can arrange for lower cost natural gas and the utility will develop a further reserve associated with the ability to shut off customers having the dual fuel capability. This project would also help reduce emissions from current high emission backup generators.

Responsiveness to CEC Goals

Current MTG OEM's are focused on establishing a market for their products. Current back up generators are relatively inexpensive. As a result, operation of MTGs as backup generators is not a high priority for OEMs.

Objectives

1. Develop the low emission fuel injection strategy necessary for operation on natural gas and a backup fuel.
2. Verify the emissions performance of the technology
3. Verify the operability and reliability of the technology

Budget

2005 : 450000
2006 : 500000
Other : 250000

Comments

Project Concept #76: Correlation of Flashback tendencies with fuel composition

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Description

In Lean Premixed Combustion, fuel and air are carefully mixed upstream of the reaction zone in order to achieve a near homogeneous temperature which is low enough to avoid excessive NOx formation. At typical conditions, a length that gives on the order of several millisecond of premixing time is common. The mixing length (i.e., time) is an important factor in determing how well mixed the fuel and air are prior to entering the reaction zone. Also, depending upon the local residence times and aerodynamics of the premixing region, autoigntion and/or flashback can be a concern. This is especially true when a given premixer design is utilized for fuels that have varying reaction rates and/or flame speeds. In the present case, this could include natural gas with associated variations in composition.

Benefits

The results of this project will lead to more efficient design of premixers for gas turbine applications which will allow OEMs to develop ultralow emissions systems faster. This will allow improved environmental quality and reduce cost of the equipment, which should lead to lower cost of electricity for the public.

Responsiveness to CEC Goals

This is a fundamental study that is not system specific. It will benefit a wide array of devices over a range of scales.

Objectives

1. provide analytical expressions for flashback as a function of combustor inlet conditions and fuel composition for several classes of generic premixers
2. provide insight into the nature of flashback in a systematic, controlled manner
3. provide a source of data for validation of advanced chemical kinetic codes for use in CFD.

Budget

2005 : 250000
2006 : 275000
Other :

Comments

Project Concept #77: Evaluation of Gas Turbine Combustor Operational characteristics when co-firing with biomass derived

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Description

The ability of a burner to operate on biomass derived fuels will provide an opportunity to extend the supply of natural gas. However, low emission operation of a system designed to operate on natural gas when operated on alternative fuels such as those derived from gasification of biomass is a challenge. This project will provide design tools to determine the impact of operation of a combustion system designed for natural gas to be operated on alternative fuels and/or alternative fuels cofired with natural gas. The co-firing operation will facilitate operation of many more devices on biomass derived fuels, therefore helping to further extend the existing natural gas supplies as well as reducing making use of biomass that would otherwise be burned or discarded.

Benefits

Lower emissions
Better management of biomass waste
Lower cost of natural gas

Responsiveness to CEC Goals

The development of infrastructure for dealing with biomass is unattractive to OEMs due to the unknown risks associated with its use for providing energy. As a result, OEMs nor regulated entities will want to invest in this research.

Objectives

1. Characterize the fundamental characteristics of biomass fuel/natural gas mixtures
2. Characterize the stability extension achievable by hydrogen mixing and/or discrete injection
3. Characterize the emissions characteristics of combustion of biomass/natural gas mixtures
4. Develop a model describing emissions and stability performance vs biomass/natural gas content
5. Apply the model and verify results for various burners (e.g., gas turbines, boilers)

Budget

2005 : 300000
2006 : 300000
Other : 150000

Comments

Project Concept #78: Active Control of combustion systems to account for fuel variability

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Description

Combustion devices that are able to meet current and future stringent emissions regulations may face issues when fuel composition varies as is expected with potential LNG introduction and general capacity issues associated with the current natural gas infrastructure. Most devices meeting the emissions regulation are "fine tuned" to operate within narrow ranges of fuel/air ratio and firing temperatures. Variation in fuel composition can compromise this performance. As a result, a system to vary combustion system operation as a function of fuel composition will allow emissions levels to be maintained even as fuel composition varies.

Benefits

Improved safety
Reduced emissions
Reduced cost of gas

Responsiveness to CEC Goals

This strategy is risky for OEM's to consider, yet offers great promise if done properly. The elements of the research are fundamental in nature and generally applicable.

Objectives

1. Assess sensors for determination of fuel composition
2. Develop relationships for combustion system operation as a function of fuel composition
3. Develop actuation for varying combustion system operation
4. Develop algorithms for actuation to improve combustion performance as fuel composition varies.
5. Demonstrate closed loop performance.

Budget

2005 : 400000
2006 : 400000
Other : 400000

Comments

Project Concept #79: Gas-Electric Interdependency Analysis and Evaluation

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Description

The Electric Power Research Institute (EPRI) proposes to study the gas-electricity interdependency as it applies to California, through a combination of practically-focused research and rapid technology development. Specifically, the proposed R&D program would:

1. Investigate current practices and tools. Most work in the area of gas and electric system interdependencies has been done by individual utilities that have interests in both areas. The proposed project will thus begin by assessing and evaluating current practices and analytical tools currently used by California utilities.

2. Develop gas-electric interdependency model(s). Power systems and natural gas systems are currently described by a variety of computer models, but no utility or gas company routinely investigates the detailed interconnection of the two systems to show their interdependencies and inter-vulnerabilities. Thus, new analytical tools and software will be developed that can model gas-electric interdependencies.

3.Estimate economic impacts of gas and/or electric interruptions. Using available economic models, the study will determine potential regional costs of major interruptions that spread from one energy infrastructure to another. For example, a terrorist attack that manages to disrupt both gas and electricity service to a region could easily cause billions of dollars of damage. This effort will estimate these impacts and provide lower and upper bounds for the forecasts. Also, parameters/variables will be identified that are significant contributors to the impact predictions.

4.Develop countermeasures. Using the results of the foregoing analyses, methods need to be developed for reducing the potential impact of major gas-electric disruptions. Given the nature of the two systems, “optimizing” the use of the inherent storage capacity of the gas network is likely to be a major element of these countermeasures. Also investigated will be the value for electricity storage / shock absorber plants placed in the electric grid to minimize the interdependency impacts.

Benefits

The anticipated benefits of this project are as follows:

• Make decision-makers more aware of vulnerabilities and interdependencies in the gas and electric infrastructure systems.

• Provide new analytical tools to make ongoing assessments of gas-electric interdependencies and improve the operation of the two infrastructure systems in a more coordinated fashion, reducing vulnerabilities and increasing efficiency.

• Evaluate economic impacts of major interruptions that could spread from one infrastructure system to another and will allow both the state and its utilities to prepare for natural disasters and terrorist threats.

• Provide methods to reduce the impact of major disruptions to the two infrastructure systems, which will be critical for protecting the citizens of California against potentially catastrophic interruptions of gas and electricity together.

Responsiveness to CEC Goals

The proposed project supports the goal of the California Action Plan to ensure “adequate, reliable, and reasonably priced electrical power and natural gas supplies.” Specifically, the project will provide new understanding about the vulnerabilities of the gas and electric interconnected infrastructure systems, thus helping to ensure adequacy and security of these two infrastructures for the State public good. The project will also develop new technologies to coordinate gas and electric system operations and construction planning, thus enhancing reliability and cost-effectiveness of these two infrastructures for the public good.

Objectives

A 2004 report, Gas/Electricity Interdependencies and Recommendations, by the Gas/Electricity Interdependency Task Force (GEITF) of the North American Electric Reliability Council (NERC), concluded that:

• Gas pipeline reliability can substantially impact electric generation;

• Pipeline and electric system operators do not understand each other's business very well; and

• Communications between pipeline operators and electric reliability coordinators are generally weak.

The proposed EPRI project would address each of these concerns by assessing current operating practices in greater depth, providing new tools that will help coordinate operations of the two energy systems, and allow system planners to coordinate construction of new electric and gas facilities. The project will also help fulfill specific recommendations of NERC to develop reliability standards relating fuel infrastructure reliability to electric resource adequacy/reliability, and to establish a monitoring system that tracks fuel infrastructure outage contingencies that could have an adverse impact on electric system reliability.

Budget

2005 : 750000
2006 : 650000
Other : 0

Comments

Some of the cost details associated with the budget numbers above are provided below:

Four tasks:

1. Investigate utility current practices and tools; The 2005 budget estimate is $100,000; and 2006 budget estimate is zero.

2. Develop gas-electric interdepe

Project Concept #80: Recuperative Reforming of Natural Gas for Fuel Savings and Emissions Reductions at Existing Reciproc

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Description

GTi and Collier Technologies,Inc. propose to confirm the technical and economic feasibility of using hydrogen, produced from exhaust gas reforming of natural gas, to provide at least 10 percent fuel savings plus major reductions in NOx emissions on reciprocating internal combustion engines used in gas transmission. Our proposed initial target market for retrofitting this technology in California are engines operated by Southern California Gas Company (SoCalGas). The proposed scope of work would include : Phase 0: Engineering study of recuperative reforming for SoCalGas reciprocating engines; Phase 1: Pilot-scale engineering design and testing of a prototype system; Phase 2: Long-term field demonstration at a SoCalGas compressor station. The deliverables will include publishable reports for all three phases of work that documents the costs, fuel savings and emissions benefits of using exhaust gas fuel reforming on the types of large bore, low speed engines used for gas transmission in California. The Phase 2 deliverable would include a commercialization plan from our manufacturing partner(s).

Benefits

For a nominal gas transmission reciprocating engine capacity of 2 MW operating at a 50 percent load factor, GTI estimates that a 10 percent fuel savings would represent about 8.5 million cubic feet of gas. SoCalGas has 70 reciprocating engines in gas transmission service. We do not have a figure for engines operated by PG&E, nor do we know the total engine population in California which could benefit from this recuperative reformer. We also estimate that exhaust gas reforming, when integrated and optimized with low NOx combustion modification, has the potential to reduce NOx by up to 80 percent from uncontrolled levels, depending upon the baseline emissions.

Responsiveness to CEC Goals

The proposed project has the potential to increase thermal efficiency by more than 10 percent (conservative target) and reduce NOx emissions by more than 80 percent when combined with exhaust gas recirculation EGR.

GTI is currently running process and engine simulations of systems for recovery and utilization of waste heat from engine exhaust gases, coolant and lubricants for recuperative, catalytic reforming of natural gas. And GTI is developing and testing systems that use some fraction of engine exhaust gases to supply the required heat, water vapor and CO2 to reform enough natural gas to produce hydrogen/natural gas fuel blends with about 30-40 percent hydrogen by volume.

This project will advance technology development currently underway.

Objectives

The overall objective in this proposed project is to combine the know-how and capabilities of the respective project teams to design and optimize a simple, yet effective, system for achieveing at least 10 percent fuel savings. We intend to achieve this objective by maximizing waste heat recovery and utilization in exhaust gas reforming to increase efficiency gains that can be realized from combustion optimization with hydrogen-enhanced natural gas.

Budget

2005 : 350000
2006 : 800000
Other : 500,000
(year 3)

Comments

Significant cost sharing from industry partners will be provided.

GTI is currently working with an engine partner to develop a recuperative reforming technology for pipeline engines in New York State. A Proposal Opportunity Notice through NYSERDA is e

Project Concept #81: Whole House Distribution Systems R&D

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Description

Zero Energy Homes (ZEH) combine state-of-the-art energy efficient construction and appliances with renewable energy systems. The objective of this approach is to have zero net energy consumption. Modifications to existing distribution systems can result in dramatic energy savings. As an example, Title 24 carries duct sealing as a prescriptive option and documents an increase in system efficiency by 20 percent. These efficiency increases are on traditionally designed distribution systems and not distribution systems that were specifically designed with zero-energy in mind.

This research will take the next step and focus on home distribution systems designed for zero energy homes, including: gas, electric, air, water, waste, ventilation/humidification, and exhaust. The project will examine and document technology and techniques currently available that maximize distribution delivery efficiency; establish optimal distribution designs for ZEH concepts that are transparent to the homeowner; assess the retrofitable aspects of these options in existing homes; and identify emerging technology such as low-cost sensors and recuperative systems that can further reduce energy lost in distribution systems. Finally, the most promising concepts would be further developed and then demonstrated in a California ZEH home.

Benefits

Optimal design systems can reduce installation costs and stand-by distribution losses, while improving energy efficiency, safety and comfort. Additional benefits from improved distribution system efficiency include reduced equipment size requirements, smaller footprint equipment, increased livable space, and reduced pollution.

Responsiveness to CEC Goals

This development research benefits the public in two ways: the energy savings accrue directly to Calfiornia ratepayers and this type of research pushes the bounds of efficiency that no manufacturer can afford to do alone.

Objectives

The key objectives of this project are technology and technique benchmarking; optimal distribution design; emerging technology integration; and demonstration in a California home.

Budget

2005 : 750000
2006 : 750000
Other : 1,500,000
total

Comments

Project Concept #82: Solar Upgrading of Natural Gas and Renewable Methane-Containing Gases for Distributed Generation

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Description

Science Applications International Corporation (SAIC) in collaboration with Florida Solar Energy Center (FSEC) proposes a two-phase program of research and development leading to the demonstration of an energy efficient and environmentally friendly process for solar-upgrading of natural gas (NG) and non-conventional renewable methane-containing gases (MCG) for distributed generation (DG) and fuel cell powered vehicles using SAIC's high-flux solar concentrators. The proposed concept is based on solar-powered catalytic processing of NG into hydrogen (or synthesis gas) that will be used in fuel cells (FC) for electricity production and vehicles. The use of solar energy input to the process allows upgrading of NG chemical energy by more than 30%. The combination of the solar-powered fuel processor with a FC would result in a 2-2.5 fold increase in the overall chemical-to-electrical energy efficiency of NG utilization (compared to conventional DG gas turbines). At the same time, the proposed power system will produce no or significantly less criteria pollutants and CO2 emissions than conventional NG-burning power plants. One of the major advantages of the proposed concept is that it is applicable to a wide range of NG sources and renewable MCG, including landfill gas (LFG), gas from waste water treatment plants and biogas from agriculture.

The high-flux, high-temperature solar heat source proposed here is based on the solar dish concentrator system developed by SAIC during the past 20 years. FSEC will perform the chemical and engineering aspects of the work, including R&D of the efficient catalyst for the process, hydrogen purification and design and manufacturing of the thermochemical reactor. The preliminary proof-of-concept experiments conducted at FSEC have demonstrated the technical feasibility of hydrogen production via catalytic processing of pipeline NG as well as CH4-CO2 mixtures that mimic LFG using a specially designed thermo-catalytic reactor with an external heat supply (simulating a solar furnace).

Benefits

Continued adequate supplies of NG for California are in jeopardy. This project concept would lead to converting NG and renewable methane-containing gases into hydrogen that would replace NG as a preferred energy delivery system in California. This proposed project concept would either use current NG supplies in a more efficient conversion process to produce electricity or use non-conventional sources of NG or methane-containing feedstocks to produce hydrogen as a supplement or replacement for NG supplies. This would be an interim cost effective step towards the sustainable production of hydrogen using renewable energy. This project concept will produce electricity with little or no air emissions of criteria pollutants and global warming gasses. It will be more efficient and produce less noise than current DPG applications. The distributed nature of this concept has public benefits in lower power distribution losses and better electrical system stability as well as better security protection due to its non-centralized nature.

Responsiveness to CEC Goals

This proposed R&D meets the definition of "public interest" because it advances science and technology, benefits California citizens and is not adequately addressed by competitive or regulated industries. Only preliminary studies have been conducted in solar generated hydrogen and therefore this work would advance the science and technology. NG is the preferred choice for electric production in California due to its current low cost and environmentally beneficial attributes. However, NG supplies are stagnant or dwindling, while the demand for NG is increasing. The solutions to this problem for California are to use NG more efficiently, import LNG, develop NG-substitutes based on renewable methane-containing gases, from non-conventional sources or replace NG with hydrogen from NG and renewables. Efficient use of NG is the best initial choice but will not resolve the complete problem. LNG has obvious

environmental and supply risks. This project directly addresses the latter two solutions. Developing a renewable and environmentally benign method for producing hydrogen to replace NG directly benefits California Citizens. Because the emphasis on hydrogen production is relatively new, very little R&D has been conducted and the current risk is too high for competitive or regulated entities to undertake this R&D independently.

Objectives

This project has as its primary objective the development and demonstration of a viable process for a solar-powered catalytic conversion of (NG) and/or non-conventional MCGs into hydrogen or synthesis gas for use in different types of FCs. A secondary objective is to build and operate a pilot-scale solar hydrogen production system to demonstrate the potential for the practical implementation, and to verify the cost-effectiveness of this approach for commercial production of hydrogen from NG and MCG.

Phase I work is to identify California sources of renewable MCGs, conduct bench scale experimental verification of optimal operational conditions of all stages of the proposed process and design the integration of this process with the solar concentration system. The outcome of the Phase I effort will include complete thermodynamic and economic analysis of the solar-thermochemical hydrogen production process. In Phase II, the SAIC-FSEC team will develop and field test a bench-scale thermochemical reactor/solar receiver system at about 5 kWth size for use with the process developed in the Phase I work. Work will be conducted in San Diego (CA), Cocoa (FL) and Tempe (AZ).

Budget

2005 : 1000000
2006 : 1000000
Other : 3000000

Comments

Project Concept Budget:

In Phase I (1 year - 2005), the bench scale experimental verification of optimal operational conditions of all stages of the proposed process including the solar concentrator integration approach will be conducted. The outcome o

Project Concept #83: Infiltration Reduction in Existing Homes

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Description

Excess air leakage accounts for 1/3-1/2 of the gas used for space heating in California. Current audit and retrofit technologies focus on caulking and weather-stripping and do not use diagnostic or advanced sealing techniques.

This project would develop improved diagnostic techniques for finding leakage sites and would develop enhanced retrofit technologies and strategies for reducing specific and typcial leaks. R&D would focus on cavity and penetration sealing approaches.

Field studies of component leakage in California are necessry to determine the important leakage sites and then develop, if needed, specific air sealing technologies (e.g. using aerosol sealants).

Appropriate audit techniques would be evaluated and if necessary improved for use in California.

Application to new buildings would have to be done in the context of the 2008 version of Title 24 and its expected ventilation requirements.

Benefits

Full implementation of the results of this work could reduce the natural gas used for heating California homes by about 20%. Reduced air leakage will also result in improved comfort because of reduced draght, which in turn could allow improved thermostat set points.

Improved metrics and diagnostics will enable a level playing field and instill consumer confidence to enable the private sector to implement changes.

Responsiveness to CEC Goals

The development of these tools and technologies must be public goods to be effective and therefore the benefit cannot be captured by the private sector.

The results will be focussed on the needs of California homes and be usable by California institutions.

Existing competitive or regulated entities have not been doing this kind of research and have no motivation to do so.

The output of this project, however, may stimulate the competitive and regulated sectors to implement air tightening programs.

Objectives

The outcome of this project would be tools that allow a 50% reduction in the envelop air leakage of existing California homes. The diagnostics and sealing technolgoies produced woud be suitable for use in State or Utility weatherization-type programs and would be developed in cooperation with the weatherization industry.

Improved database of the air tightness of the California housing stock would be produced.

Appropriate audit techniques would be documented.

Budget

2005 : 400000 2006 : 400000 Other : 500000

Comments

Air tightening is limited by the need to provide sufficient ventilation. Part of this project is to use existing ventilation standards to define this limit and, when necessary, take mechanical ventilation into account.

Project Concept #84: Development of metrics and quantification methods for geographically and temporally varying air qual

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Description

In this project, we propose to define the cost estimation and quantification issues created by considering temporal and spatial variations in air quality impacts. The research will also specify analytical approaches for including these considerations in the cost/benefit analysis of policies and programs. The refinement of cost quantification issues and approaches provides the metrics that can be used to translate physical and health impacts into defined quantities. This research will begin the process of binning emissions, incremental air quality impacts, and exposure into different geographical regions and temporal bins. This will allow the variability and dependence of air quality impact costs as a function of space and time in California to be efficiency considered in policy and program design.

Benefits

The public benefits of the this project are two-fold: (1) Facilitating more effective or less expensive air quality impact mitigation by identifying load-shifting and project siting locations that provide new ways of reducing air quality impacts, and (2) Facilitating new policies mechanisms for reducing air quality impacts by improved binning of emissions allowances in both space and time.

These improvements could lead to more cost effective and productive improvements in air quality resulting in potentially several percentage point decrease in air quality improvement costs throughout California.

Responsiveness to CEC Goals

A public interest project is one that produces benefits for residents of California, and is not adequately addressed by competitive or regulated entities. Developing improved policies and more cost effective methods for enhancing environmental quality produce benefits for the residents of California and are generally not addressed by competitive or regulated entities.

Objectives

To provide mechanisms for properly considering the relative variability of unit natural gas use costs and impacts on air quality as a function of geographic region (air quality district or county), day type, season, and time of day, and to design policy and program approaches that respond appropriately to this variability. This is important because the supply and demand for natural gas is responding to geographically and temporally variable prices. Meanwhile emission allowance markets and emissions regulations generally trade and regulate annual emissions quantities of limited geographic scope and that lack seasonal, daily, or time-of-day resolution.

Budget

2005 : 150000
2006 : 100000
Other :

Comments

Project Concept #85: Repowering of California Utility Boiler Plants Study

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Description

A study is proposed to evaluate various repowering options by the addition of gas turbines in existing boiler plants to assess the improvement in efficiency and reduction in the cost of generating power and environmental signature. Two types of repowering can be incorporated in an existing plant: (1) installing a gas turbine and utilizing its exhaust as combustion air to the boiler while the boiler continues to operate on natural gas (WINDBOX REPOWERING) and (2) retiring the existing boiler and converting the facility to an unfired combined cycle by the installation of gas turbine(s) and utilizing the existing steam turbine and BOP equipment (COMBINED CYCLE REPOWERING). Within the first concept, a number of options are available: either to cool the gas turbine exhaust to the temperature acceptable by the existing boiler windbox by generating additional steam or preheating boiler feed water, or to upgrade the windbox and duct the hot gas turbine exhaust directly to it. The size and type of gas turbine (pressure ratio) dictate the configuration for this type of repowering. This type of repowering has the advantage of minimizing the initial investment cost, minimizing the downtime for the existing power plant while the capacity addition realized is limited as compared to the other option consisting of converting the existing facility to an unfired combined cycle. Significant portion of the NOx present in the gas turbine exhaust is expected to be destroyed in the boiler. On the other hand, the thermal efficiency of the unfired combined cycle plant will be significantly higher.

Benefits

The study will asses repowering utilizing the new generation of gas turbines such as the GE aero derivative intercooled gas turbine (LMS100) as well as the heavy frame gas turbines. It is expected that the California rate payer will directly benefit from the savings incurred in the operating cost of generating power as well as the improved environmental signature. Reliability of the repowered plants may also be expected to be better than the old steam plants.

Responsiveness to CEC Goals

Many of California's existing utility plants generate power using the Rankine cycle whose efficiency is significantly lower than what can be realized by the addition of the gas turbines. The efficiency of a sub-critical boiler is typically around 40% (LHV) when fired on natural gas while that of a gas turbine combined cycle is as high as 55 to 60% (LHV) depending on the gas turbine technology employed. It is expected that LNG imports will off-set the depletion of natural gas and will peg the cost of the fuel at approximately $4.00/MMBtu HHV. At high fuel prices, the efficiency of power generation plays an even more significant role. The modern gas turbine based combined cycle plants because of their higher efficiency reduce the specific CO2 emissions (on a per kW of power generated), this specific emission being directly proportional to the net heat rate of the power plant. Single digit NOx emissions are achievable with the modern gas turbines and further reductions in NOx can be achieved by the installation of SCRs. The CO emissions can be minimized by installing of catalytic oxidation units. The water consumption in the case where wet cooling towers are employed is also reduced. Where once-through cooling water is utilized for heat rejection, thermal pollution is reduced.

Objectives

For a selected number of boiler plant sizes / scenarios, the study will evaluate the various repowering options in order quantify the improvement in thermal performance and environmental signature that can be achieved, rough order of magnitude capital expenditure requirements, and recommend the most suitable repowering option for a given boiler plant size / scenario. An assessment of the re-use of existing equipment will be made as well as the existing power plant downtime required for implementing the

repowering options. For the Impact of utilizing dry cooling towers in order to conserve water or minimize thermal pollution will also be quantified. For the Windbox repowering option, the applicability of the recently introduced GE aero derivative intercooled gas turbine (LMS100) will be made where the intercooled heat may be utilized for boiler feed water preheating while its very high pressure ratio causes its exhaust temperature to be low as compared to heavy frame gas turbines.

Budget

2005 : 180000
2006 : 180000
Other : 360000

Comments

Project Concept #86: Feasibility of Integrated LNG Peak Shaving/Vehicle Fueling Networks

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Description

Unlike the present situation in California, utilities and their ratepayers in the US Northeast and Midwest benefit from the presence of over 100 small (less than 2 Bcf storage and 400 MMcf/d output) LNG peak shaving (i.e., gas storage) facilities that compliment and/or supplement the benefits of utility system access to conventional gas storage facilities. The LNG typically is produced by liquefying pipeline system gas either at the peak shaving facility, or it is transported from centralized liquefication facilities (or an LNG import terminal, if one is present in the region) to remote satellite storage units by truck, rail or barge. In this regard, the LNG peak shaving concept compared to conventional, centralized gas storage systems is similar to the difference between centralized power generation and distributed generation - it is a more efficient, "modularized" structure, and lessens the potential environmental impacts of developing larger underground gas storage and associated pipeline transmission systems. This "distributed gas storage" concept can be economically combined with distributed or "hub-and-spoke" LNG vehicle fueling facilities to facilitate the deployment of clean-fuel fleet vehicles, government and private. By combining the decades of LNG engineering, permitting and operations experience of Project Technical Liaisons Associates, Inc. (PTL) and the quantitative energy market analysis, strategic business planning and public policy expertise of ICF Consulting, regulators, utilities and private enterprise in California can benefit from a comprehensive research effort to determine the optimal structures for establishing an integrated network of LNG peak shaving and vehicle fueling systems that can be developed, owned and operated by the utilities, private enterprise, or a joint effort between the two. ICF and PTL are also qualified to implement any follow up activities leading to establishment of fully operational

Benefits

Among the potential public benefits of the project concept, which it is the intent of the research program to quantify, would be a distributed network of gas storage facilities that could help utility systems better manage price volatility of natural gas to core customers, operationally balance their pipeline systems more efficiently and utilize existing pipeline infrastructure more efficiently compared to "centralized" gas storage operations. The added presence of the vehicle fueling components at distributed locations would efficiently create a network of accessible fueling stations without the need for separate facilities to evolve a network of their own, thus minimizing the overall environmental impact of such development.

Responsiveness to CEC Goals

The research project serves the public interest in several ways. First, it contemplates an action (i.e., evaluation of the integrated LNG peak shaving/vehicle fueling networks) that transcends the domain of current planning mandates on the part of the utilities, regulatory agencies and potential private enterprise partners, and sets the stage for a joint effort that would be more comprehensive, transparent and productive than if left to any one of the aforementioned entities to evaluate (or implement) on their own. This would increase the likelihood for a broadbased, reasoned and mutually beneficial outcome for all, which would benefit the public interest. Second, the subject concept holds potentially significant environmental benefits in that utility system stability and management of system supply/demand balance can be facilitated in a manner that minimizes the need for environmentally disruptive and less efficient "centralized" gas storage in underground facilities that also require incremental pipeline transmission facilities. Finally, the integration of the vehicle fueling component facilitates the ability of fleet vehicle operators to incorporate the use of clean burning natural gas in lieu of other less environmentally friendly fossil fuels. (The concept can also integrate well with future technologies such as hydrogen-fuel vehicles, as the distributed presence of the natural gas storage could serve as a source feedstock for fuel-cell technologies.)

Objectives

The research program would produce a thorough economic, technical, regulatory and market appraisal of which areas in California could benefit from the integrated LNG peak shaving/vehicle fuel concept, including a quantification of the risks/rewards profiles under various energy forecasts (supply and demand) based on the input and close cooperation of agencies such as the US DOE, EIA and GTI, and state agencies such as the CEC, CPUC, CalEPA and AQMD. Technology, economics, environmental assessments, regulatory and business risk/rewards would be integrated into recommendations for consideration of action by utility system planners, regulators and other stakeholders as appropriate.

Budget

2005 : 100,000 - 250,000 (Feasibility, modeling, etc.)
2006 : 0
Other : Function of involvement with network implementation

Comments

California recognizes the environmental benefits of replacing gasoline and diesel vehicle fuels with cleaner burring fuels such as natural gas, and various agencies are researching the attainability of this goal, sometimes in the absence of the degree of

Project Concept #87: Quantifying the impact of renewable energy and energy efficiency investments on natural gas prices

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Description

Renewable energy (RE) and energy efficiency (EE) policies are often justified by direct consumer and social benefits—e.g., reduced fuel imports, life cycle cost savings, lower carbon emissions. In recent years, the potential for RE and EE to serve as a hedge against natural gas price and supply risks has also received heightened policy attention. Despite this attention, there have been relatively few efforts to directly quantify the consumer or social benefits of this hedge.

This study will focus on one specific potential "hedge" benefit of renewable energy and energy efficiency: the impact of RE and EE on reducing natural gas prices. Several recent modeling studies have shown that this impact may be significant, but these studies have had little empirical basis and have not focused on California in particular. The principal goal of this project will be to help understand and quantify a potentially significant benefit of RE and EE to California consumers that has, thus far, received scant attention.

To undertake this analysis, the focus will be on the shape of the long run supply curve for natural gas. There are three primary sources of information that can be used to evaluate the shape of the supply curve: economic models of natural gas markets, scarcity indices (trends in natural gas price, cost, scarcity rent, and exploration cost), and geological inference. This project will review and analyze existing information about the supply curve provided by these sources and make an informed judgment about the impact of RE and EE on natural gas prices. Based on these findings, we will seek to develop simplified analytic tools that might be used by the CEC, CPUC, and others to estimate these beneficial impacts.

Benefits

We anticipate that our study will improve analysis of the consumer benefits and costs of RE and EE investments and policies. Incorporating natural gas price impacts may reveal that some seemingly non-cost-effective RE and EE investments and policies can be justified economically.

From a national perspective, the economic benefits may be quite large. A preliminary review of existing national energy models suggest that each 1 percent reduction in national natural gas demand could lead to a 0.75 to 2.5 percent reduction in national wellhead gas prices. Given short-term regional supply and transportation constraints, the short-term, regional impacts may be even greater.

A crude estimate of these benefits on a national basis is obtained by assuming conservative energy model natural gas price impacts from RE and EE investments (i.e., a 1 percent reduction in national gas demand leading to a 1 percent reduction in long-term prices). In this instance, we estimate that existing state renewables portfolio standards (16 states, 16,000 MW of potential new RE) could provide national consumer gas savings of $1.6 billion in 2025 alone, equating to an external consumer benefit equivalent to $20/MWh. Similar results are found for energy efficiency investments.

Responsiveness to CEC Goals

The project envisioned here is primarily intended to develop tools to better quantify the beneficial impacts of RE and EE investments in reducing natural gas price and supply risks in California. As such, the project is focused on identifying benefits to California citizens, and this area of research has not yet been adequately addressed by other parties.

The project specifically emphasizes the impact of energy efficiency, renewable technologies, and conservation on natural gas prices, and supports the proposed "loading order" in the California Energy Action Plan by providing tools to better estimate the consumer benefits of increased RE and EE investments. Assuming that such tools can be developed, we believe that the benefits to California will

primarily come from improved methods to evaluate the beneficial impacts of enhanced RE and EE investments and policies.

Objectives

In the Energy Action Plan, California's principal state energy agencies have created a "loading order" for new acquisitions that indicates a clear preference for energy efficiency, conservation, renewable energy, and distributed generation. One of the reasons for this preference is the beneficial impact of these resources in reducing the State's dependence on natural gas. And yet, few analytic tools yet exist to quantify the consumer benefits of reduced natural gas dependence. This project will seek to rectify this deficiency.

The key objective is to develop credible tools that CEC and CPUC analysts (as well as others) can use to estimate the potential consumer benefits of RE and EE in reducing natural gas prices. The project will therefore help CEC analysts better evaluate the consumer benefits of RE investments and policies, electric EE investments and policies, and direct natural gas efficiency improvements.

Budget

2005 : 200000
2006 : 100000
Other :

Comments

Project Concept #88: Natural Gas Efficiency

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Description

Natural Gas Efficiency

Benefits

Increase uses of natural gas will increase the cost of natural gas to ratepayer utility bills. Simple supply and demand economics will confirm this tenant.

Responsiveness to CEC Goals

Meets intent of CPUC criteria that any commercial benefits resulting from public interest R&D accrue to ratepayers. It is Public Interest RD&D activities that are directed towards developing science or technology, 1) the benefits of which accrue to California citizens, and are not adequately addressed by competitive or regulated entities.

Objectives

Keep ratepayer funding away from new uses of natural gas. No funding from ratepayer monies should be allowed to project proposals that explore or intend to use more natural gas. New products or services for uses of natural gas usage should be strictly forbidden.

Budget

2005 : 0
2006 : 0
Other : 0

Comments

Project Concept #89: Photovoltaic / Thermal Collectors (PV/T) R&D

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Description

Photovoltaic / Thermal Collectors (PV/T) R&D. California has installed 79 MW of grid tied photovoltaics. This represents at least 79 MW of untapped, wasted thermal energy available off the backside of the PV modules. Capture of heat off PV modules increases the electrical production from the PV modules, providing potentially 10% more peaking power when needed the most, on sunny summer days.

Benefits

New emphasis in California on Zero Energy New Homes, and the Governor's interest in solar on new construction, makes this PV/T proposal very appropriate for the investor owned utility ratepayers of California. Appropriately oriented and configured photovoltaic systems have demonstrated their ability to generate electricity coincident with system peak hours during the summer. Significant new housing growth in both the near and long term is anticipated to occur in California's urban areas and hot inland regions. Almost every home in California uses electricity, and either uses natural gas or electricity to heat water; thus the market potential for peak matching electricity and thermal energy from PV/T is very large. We propose the investigation of the technical merit of PV/T collectors to reduce the dependence on natural gas and peak electrical consumption for residential buildings and commercial buildings in California. Reduced natural gas at the residential site will enable the unused natural gas to be used at investor owned utilities' combine cycle natural gas turbines to produce the most environmentally preferred, central station electricity. California currently depends upon these turbines for peak power. Thus, thermal energy from PV/T collectors allows for lower costs of investor owned utility generated electricity. Increased energy and peak power production occur

Responsiveness to CEC Goals

Meets intent of CPUC criteria that any commercial benefits resulting from public interest R&D accrue to ratepayers. It is Public Interest RD&D activities that are directed towards developing science or technology, 1) the benefits of which accrue to California citizens, and are not adequately addressed by competitive or regulated entities.

Objectives

To research and develop heat harvest and added peaking benefits from photovoltaic modules.

Budget

2005 : 1000000
2006 : 1100000
Other : reduced 10% per year

Comments

Project Concept #90: Solar Thermal Collaboration

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Description

Set up collaboration in the state of California, similar to the existing wind and biomass collaborations under PIER Renewables. This Solar Thermal Collaboration would eliminate obstacles to the use of solar thermal flat plate collectors on new and existing buildings. Solar thermal flat plate is three times more effective at converting solar radiation to usable thermal energy, and one third the cost of more sexy photovoltaics.

Benefits

Reduced natural gas at the residential site will enable the unused natural gas to be used at investor owned utilities' combine cycle natural gas turbines to produce the most environmentally preferred, central station electricity. California currently depends upon these turbines for peak power. Thus, thermal energy from flat plate solar thermal collectors allows for lower costs of investor owned utility generated electricity.

Responsiveness to CEC Goals

Meets intent of CPUC criteria that any commercial benefits resulting from public interest R&D accrue to ratepayers. It is Public Interest RD&D activities that are directed towards developing science or technology, 1) the benefits of which accrue to California citizens, and are not adequately addressed by competitive or regulated entities.

Objectives

Collaboration that breaks down the barriers to builders adoption of solar thermal flat plate. All construction can include solar thermal in the future as an objective of the collaboration. This is accomplished in Israel and Australia, why not California?

Budget

2005 : 500000
2006 : 500000
Other : reduce 20% / year

Comments

Project Concept #91: Heat Activated Industrial Drying Heat Pump

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Description

A highly efficient gas fired industrial drying concept is proposed. This concept will deliver high efficiency gas drying by heat pumping with an innovative absorption cycle. Heat pumped gas fired drying will be 30% more efficient than existing technology. Advancements in absorption technology have made drying available at 180oF, a typical temperature required for drying applications. The hot end heat source will be natural gas combustion. The cold end heat source can be 1) reject heat from a process stream; 2) ambient air cooling; or 3) production of useful refrigeration. The absorption cycle is a novel ammonia-water single effect cycle, which uses common materials of construction and commercially available heat exchangers and components. Delivery of 180oF temperatures has been demonstrated in previous research, but this concept has never been applied to industrial drying. Basic scientific research still needs to be performed to optimize the exchange between the drying air and the heat delivery components of the absorption system. The absorption heat pump cycle operates at an efficiency of 150%, translating to a gas savings of 30% compared to conventional drying methods.

Benefits

Natural gas consumption will be reduced for industrial drying by 30%. Across the state, it is estimated that 4 to 5% of all natural gas is used for industrial drying applications. This works out to a net reduction in natural gas consumption of 1.2 to 1.5% over current levels. This decrease in gas consumption due to implementation of this technology will lead to lower operating costs for food processors, lumber dryers, and textiles plants. This will strengthen the viability of these industries as they compete with lower international labor rates, and cheaper energy rates in neighboring states. Lower costs can also be passed along to consumers, allowing the industry to remain competitive with international competitors.

Responsiveness to CEC Goals

This proposed concept meets the “public interest” objectives by reducing natural gas consumption in a key industrial process. Benefits will accrue to rate payers by lowering costs of finished goods from the targeted industries. Lowered costs will result from lower operating costs in the food processing, lumber, and textiles drying industries. Since the technology involves burning less natural gas, implementation will result in a decrease in greenhouse gas emissions, and therefore increase environmental quality. Decreasing natural gas usage will also free up gas availability and reliability of supply.

Objectives

The most important objectives of this project are 1) to demonstrate the feasibility of this technology in key applications; and 2) to quantify the potential benefits and market size. Key applications are California’s extensive food processing industry, including dairy (cheese making, powdered and condensed milk manufacture); dried fruits (raisins, prunes, apricots); and vegetables. Other key applications include lumber drying and textiles drying. Existing processes and practices will be studied in detail to ensure optimal integration between new technology and existing equipment. Quantifiable benefits will be determined in terms of gas savings, consumer benefit, industry benefit, and environmental quality improvement. A successful project will include demonstration of the technology at several replicable target applications; measured performance and economic benefits; and a justifiable estimate of the potential state-wide gas savings, and economic benefit to the industry and consumers.

Budget

2005 : 500000
2006 : 1000000
Other : 1,000,000 (2007)

Comments

The University of California – Davis operates the California Institute of Food and Agriculture Research, and is a leader in food drying and processing. ECC would draw on the expertise of CIFAR for this project.

Project Concept #92: Adding retail gas tariffs to a web-based residential energy analysis tool

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Description

Consumers, consumer advisors, energy service providers, and policy analysts need improved tools to evaluate the economic impacts of shifting among tariffs and from behavioral or technical actions taken to reduce gas consumption. The proposed work enhances the existing web-based Home Energy Saver (HES) residential energy analysis tool (http://HomeEnergySaver.lbl.gov) to include real-world gas tariff structures and fixed/meter charges, rather than flat rates (dollars per therm) as is currently assumed. HES is a whole-house tool using the DOE-2 engine to model HVAC energy and other methods developed at LBNL to model all other end uses in the home. The site currently sees approximately 500,000 visits per year, most of which are from residential consumers. Conventional tiered "block" rates and perhaps other types of tariffs will be incorporated, so as to make estimates of savings more realistic. This work will build on recently completed work–funded by PIER–that successfully added block and time-of-use electricity tariffs to the HES tool.

Benefits

The expected benefit of this project will be energy savings induced by the information provided by the Home Energy Saver tool. In a recent survey of 1000 HES users, about 1/3 of respondents report taking action to reduce their energy use based on the information and recommendations provided by the HES Web site. Assuming 10% of the HES visitors are from California, and those making upgrades to their house save 10% of their annual gas consumption, total annual savings in California due to HES could be 175,000 therms. In addition, the tariffs added in this project would be available on-line (http://tariffs.lbl.gov) for public use, and accessible for 3rd-party bill calculators.

Responsiveness to CEC Goals

1) Focus on energy efficiency, renewable technologies, conservation and environmental issues:

This project helps people understand their energy use and ways to reduce their household energy bills.

2) Support State Energy policy, see California Energy Action Plan for information on related policy objectives (www.energy.ca.gov/energy_action_plan/)

This project supports Energy Action Plan Goal I: Optimize Energy Conservation and Resource Efficiency. Under that goal, it specifically addresses the sub-goal to "Improve New and Remodeled Building Efficiency." The users of the Home Energy Saver web tool are almost entirely occupants of existing buildings, offering an effective outreach vehicle for the remodeling market.

3) Offer a reasonable probability of providing benefits to the general public:

This project will benefit Californians by providing better information about how changes to their house can reduce natural gas bills. It also will allow them to investigate the effect of changing tariffs or natural gas supplier.

4) Consider opportunities for collaboration and co-funding opportunities with other entities:

The HES tool is substantially co-funded by the U.S. Department of Energy (and the U.S. EPA).

Objectives

Consumers will be able to obtain much more realistic estimates of their natural gas costs and savings potential than is possible with any currently available software tool. This will be accomplished by:

- Modifying HES energy models to calculate monthly gas consumption.
- Modifying HES user interface to allow users to select tariffs and view results from tariff calculations.
- Compiling California natural gas tariffs and making them available in an on-line database (http://tariffs.lbl.gov)

Budget

2005 : 50,000k
2006 : 25000
Other :

Comments

A comprehensive effort for residential web-tools development would be on the order of $250k per year. These additional efforts would provide additional functionality in HES to improve the modeling of natural gas end-uses and energy-saving technologies, al

Project Concept #93: The Road to True Zero Energy Homes in Californa

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Description

In April 2003, KEMA-XNERGY issued a comprehensive report on the residential end-use energy sector entitled, California Statewide Residential Sector Energy Efficiency Potential Study. Water heating accounts for 38% of the gas consumed in the typical California home. Space heating accounts for 44% of the total. 82% of residential gas consumpiton is thus for water and space heating. These large residential thermal loads are the primary gas savings targets of opportunity.

In Section 7 of this report the author's find that the utilization of solar water heaters to agument natural gas water heating provides the single greatest savings resource: Over 800 million therms a year in potential savings. Projects that advance residential domestic solar water heating therefore must be given a very high priority in this Program.

In California residential solar domestic water heating will save 40 - 80% of the gas consumed for water heating, depending upon the type of system installed. An identical amount of pollution from each gas heater is also abated at the source. Reduced CO2, NOx, and SOx emiissons have obvious air quality benefits that are quantifiable.

Off the shelf solar water heating systems are available. No proof of concept is required or necesary. A substantial residential pilot program in coordination with a large CA. builder would be helpful in overcoming past problems and/or uncertaintites relative to this technology. SunEarth proposes to conduct this pilot in conjunction with a large CA homebuilder.

A second approach would be to design and develop an integrated and aesthetic solar water and space heating system. Such a project has real merit in conjunction with the Department of Energy's Zero Energy Homes initiative - clearly these large thermal loads are singularly unsuited for photovoltaic solar electricity. They must be met by advanced solar thermal technology. SunEarth also would propose to work on this integration concept in coordination with at least one preeminent California builder partner.

Benefits

Responsiveness to CEC Goals

The focus here is on energy efficiency, reneewable energy, solar thermal technology advancement, and pollution abatement.

Objectives

California's builders must understand and embrace solar thermal technology. Both of the projects outlined above will unite SunEarth Inc., California's largest solar thermal manufacturer, with California builders to develop the skills, familiarity and experience to begin integrating cost-effective solar thermal tehnology in new construction. This, again, is the largest area of potential gas savings in the residential sector going forward.

Budget

2005 : 1500000
2006 : 1750000
Other : 2000000

Comments

It is SunEarth's sense that the Zero Energy Homes concept has tremendous potential and merit for California. A truly integrated approach is called for. This effort must combine solar thermal and photovoltaic solar electricity to be successful. The chal

Project Concept #94: Fuel Cell Demonstrations for California Applications

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Description

Plug Power Inc. proposes that the California Public Interest Natural Gas Research and Development effort focus on the installation of natural gas fuel cell systems installed in a distributed manner and on-site hydrogen generation from natural gas to support five objectives in California that will provide clear benefit to the California natural gas ratepayers. Plug Power Inc., a Latham, NY-based fuel cell manufacturer of Proton Exchange Membrane (PEM) fuel cells has a major focus on the California marketplace. This program, as envisioned, would encompass two elements including demonstration and cost buydown components to provide near-term incentives for the deployment of fuel cells in meaningful numbers in commercial and state government settings.

1) Installation of natural gas fuel cells at residential locations in the California markets in conjunction with gas utilities, homeowners, and residential developers and building contractors. These systems would serve to generate electricity and heat at the point of use.

2) Installation of natural gas fuel cells at commercial locations in the California markets in conjunction with gas utilities and developers and building. These systems would serve to generate electricity and heat at the point of use.

3) Installation of natural gas fuel cells at high schools, community colleges, and universities within the California educational system in conjunction with school districts and other educational organizations to provide outreach and education for students, builders, architects, and the California ratepayers in the potential for fuel cells, develop fuel cell technology training opportunities, and generate electricity and heat at the installed locations.

4) Installation of natural gas fuel cell systems in state government facilities in conjunction with California state government entities supporting the Governor's focus on developing alternative sources of energy as well as supporting actions II, IV, and V of the State of California's Energy Action Plan.

5) Utilization of fuel cell technology to generate hydrogen from natural gas for industrial, commercial, and transportation needs within the state.

Benefits

Fuel cell systems leverage fuel cell technology and the advantages of the distributed power generation model to experience reduced emissions levels when compared to incumbent power generation technologies. The electro-chemical process within a fuel cell combines hydrogen and oxygen to form water. The transfer of electrons during this reaction is harnessed for electricity. The exothermic nature of the reaction generates waste heat that can be reclaimed by the end-user.

Placing this type of power generation device at the point of use eliminates the line-loss and inefficiency experienced with the centralized generation model and results in an overall more efficient system. Fuel cell systems have a nominal electrical efficiency of 27%. With waste heat reclamation, overall efficiency can exceed 80%.

The CO2 levels of fuel cells are comparable with the other technologies where carbon into the system equals the carbon leaving the system. Reductions in emission rates can only be achieved through efficiency increases; either with the technology or the overall transmission and delivery system. The distributed nature of broadly dispersed fuel cells in significant numbers advances this fundamental principle and reduces transmission/delivery losses dramatically.

Responsiveness to CEC Goals

As outlined in the State's Energy Action Plan, value to the ratepayers will be provided by ensuring reliable, affordable, and high quality power, accelerate renewable resource generation, and promote

customer and utility owned distributed generation. California has begun the process of eliminating barriers to fuel cells through CARB's Distributed Generation Certification and through the CEC's Rule 21 standards for grid interconnection. Continuing the process of eliminating barriers through funded incentives focused on the five areas outlined in the description of this program are essential and timely. Long-term benefit to the ratepayers will be realized through the application of distributed generation in California, public education and outreach aimed at generating understanding and acceptance of fuel cells and hydrogen as a viable source of energy, and in sufficient numbers, reduction in the need for centralized power plants to provide energy required for economic growth in California.

Objectives

While fuel cell technology offers the potential to provide energy in a highly efficient, environmentally sound manner that will provide clear benefit to the California marketplace, it is a new technology that must overcome a significant number of barriers in addition to cost in order for the benefits to be realized. Plug Power would propose that the focus of the CEC's efforts in this area be on reducing these barriers in a manner that would decrease and ultimately eliminate the need for outside support over time. Two key barriers – cost and public awareness are areas that this program can and should address as key program level objectives.

Budget

2005 : 4000000
2006 : 8000000
Other :

Comments

The US Department of Defense programs - the PAFC and PEM Demonstration Programs and the Climate Change Buydown program provide two working models that are worthy of consideration in developing the framework for this program. These programs have provided

Project Concept #95: Clean High Efficiency Hydrogen Power

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Description

This project "Clean High Efficiency Hydrogen Power" (CHEHP) aims to develop cost effective NG reforming technologies and integrate them in downstream existing combustion power generation systems. The ultimate objective is to demonstrate higher efficiency of an integrated reformer and power plant while significantly reducing emissions.

It has been established that optimal integration of power plants and reformers is required for achieving higher overall efficiencies. We intend to investigate whether a mixture of natural gas and hydrogen can be used in power generation units under conditions that are safe, reliable, and economically and environmentally sound. This development will leverage the synergies between developing hydrogen technologies and existing power systems, opening options for practical future development. The research will also determine the feasibility of achieving dry NOx control for hydrogen doped natural gas combustion, the most effective technology for NOx reduction. The primary focus is gas turbines for power generation, but the assessment will also include internal combustion engines. A balanced integration of flow, thermal, mechanical, electrical, and controls systems is critical to achieving satisfactory efficiency, operability, and reliability.

GE will use a conceptual process to identify key integration trade-offs for gas turbines and internal combustion engines from both hydrogen doping and process integration perspectives. Using conceptual process designs for each reformer candidate approach, interactions between the power island and balance-of-process will be captured with functional block diagrams.

GE is a leading research organization focused on the development and implementation of novel technologies. GE expects that this effort will deliver technology that will benefit California for a clean, efficient and reliable power generation using de-carbonized fuels. GE envisages that while this program will deliver technology for a clean energy economy and at high efficiency of operation, it will help define new safety and reliability for Power Generation using de-carbonized fuels.

Benefits

The partial reforming of natural gas in an optimally integrated system could improve the overall efficiency present day reformer-power plant coupled systems by 1-2 %. Utilization of hydrogen will not only improve combustion efficiency and therefore operability of existing systems, but also lower the power island CO2 emissions. The CHEHP demonstration project will enable the development of methodology and reforming and combustion technologies that facilitate the optimal future integration of the CO2 capture technologies and hydrogen utilization in combustion systems. The main benefits to California are:

- Demonstration of an optimized integrated power system (coupled reformer with NG/hydrogen fuelled gas turbine or ICE power generation) that can meet or exceed anticipated requirements for California emissions, provide wide operability and cost effectiveness, while preparing the ground for reduction of net GHG emissions;
- Evaluation and demonstration of technology options for combustion control of NOx, CO and other combustion species with blends of hydrogen and natural gas fuel for a California power generation plant;
- Development of a methodology and of reforming and combustion integration that enables the optimal future integration of the CO2 capture technologies;

Responsiveness to CEC Goals

By using a blending of natural gas and hydrogen (resulted from the partially reformed natural gas) for fueling the power-generating unit, NOx emissions as well as CO2 emissions can be reduced significantly, while improving combustion stability and therefore operability. CHEHP will demonstrate at least four public benefits to California:

- An increased overall efficiency plant through demonstration of a high-efficiency integrated reformer and power generation unit technologies in accordance to CPUC;
- An improvement in the California environmental quality by lowering emissions of NOx and CO2 from the power generation unit via utilization of up to 30% H2 in the fuel;
- Leveraging GE worldwide efforts in development of hydrogen production and utilization technologies in a California application
- GE readiness for future de-carbonized or reduced carbon power generation technology that enables the optimal future integration of the CO2 capture technologies.

Objectives

It is anticipated that by utilizing a mixture of NG with hydrogen (up to 30% by volume) as fuel for gas turbines or reciprocating engines, an increase in the overall efficiency of the integrated plant can be obtained while improving combustion stability and lowering NOx. The fuel mixture is obtained via partial reforming of natural gas in an optimally integrated system. The key objectives are:

- to demonstrate that optimization of the overall integrated power system (coupled reformer with NG/hydrogen fuelled gas turbine or ICE power generation) can meet or exceed anticipated requirements for California emissions, provide wide operability and cost effectiveness, while preparing the ground for reduction of net GHG emissions;
- to evaluate and demonstrate technology options for combustion control of NOx, CO and other combustion species with blends of hydrogen and natural gas fuel in a California power generation plant;
- to design and develop the methodology, reforming and combustion technology that enables the optimal future integration of the CO2 capture technologies;

At the end of this R&D effort, GE will demonstrate the optimal integration of a natural gas reformer and a retrofitted power generation unit (GT or reciprocating engines) that guarantees higher overall efficiency, lower emissions and better operability than systems currently operating in California.

Budget

2005 : 1000000
2006 : 1000000
Other :

Comments

Project Concept #96: Hot Water Distribution System Improvements

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Description

In California, about 40% of residential gas consumption is by gas water heaters (about 200 therms annually per household or 1.8 billion therms/year statewide). Research has shown that there are significant opportunities to reduce hot water loss in households, which would result in less natural gas consumption by the residential sector. This project will develop and implement innovative monitoring techniques to measure how much hot water is wasted in current California housing stock. Temperature at all end-uses will be recorded along with flow rates at fine enough temporal resolution to determine what fraction of hot water, by event and by volume, is wasted, either because it is discarded because it is not hot enough, or because it is not delivered as usable hot water.

The results of this project will be greater understanding of where hot water is wasted and how we can make reductions in losses. Broadly, this project will also address issues involving energy savings and reducing NOx emissions.

Benefits

Rough estimates are that the cost of this wasted energy and water (including waste water treatment) is on the order of $500k to $1billion per year. This project will provide the foundational research to be able to cost-effectively reduce this waste significantly.

Other benefits are to increase consumer convenience by reducing the wait until water gets hot enough to use. This will be an improvement of services to consumers.

Also, the reduction of demand for hot water will reduce the natural gas consumption by water heaters. This will lead to reducing on-site emissions of CO2 and NOX. Reduction of NOX emissions will benefit the state's air quality.

Responsiveness to CEC Goals

This project will meet the public interest of residents of California by reducing energy consumption of gas water heaters in California. This will be accomplished by reducing the amount of hot water required from water heaters.

This problem of having to wait for hot enough water, while vexing for consumers is not being adequately addressed by the market. Water heater manufacturers have no incentives to address the problem. Builders have not been given plumbing designs to solve this problem.

Objectives

This project will research the energy losses caused by current hot water distribution system designs. Current estimates are that on average about 20% of hot water delivered by water heaters is either discarded or not used as hot water. Research to determine how hot water is used and how much is not used will form the basis of improved plumbing system design for new construction and to determine optimum retrofit designs.

Budget

2005 : 500000
2006 : 1000000
Other :

Comments

Water suppliers are also very interested in this problem because of the opportunity for reducing wasted water. A proposal for a companion to this project is being develop for submittal to the Department of Water Resources.

Project Concept #97: The Air Quality Impact of Distributed Generation on a Regional Scale

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Description

The use of Distributed Electricity generation (DG) is expected to increase, driven by the introduction of dynamic electricity pricing, and reluctance to depend on external supplies, especially following the California electricity crisis. In addition, the cost-effectiveness of CHP plants increases the likelihood that at least some DG will occur year-round rather than only at peak-demand times. However, given the air quality crisis in the San Joaquim Valley, as well as the borderline situation in the major metrpolitan areas, it is critical to evaluate the future air quality (AQ) impacts of DG. These AQ impacts could be large for the simple reason that the high-temperature/stagnant-atmosphere episodes which occur in late summer and fall result both in high ozone concentrations (due to favorable photochemical and meteorlogical conditions) and in higher electricity demand (air conditioning). The high demand in turn leads to high electricity prices from central utility generators (CUG), which triggers DG production. i.e. DG has a tendency to be utilized at the worst possible time from an AQ standpoint. The increased ozone exposure would have both a hidden health cost to the public, as well as a rise in the number of ozone non-attainment days which would result in fines from the EPA as well as loss of federal funds.

A logical approach to evaluate such a sitution requires a combination of an economic model that incorporates demand/supply price dynamics with an AQ model that incorporates meteorology, emissions and atmospheric chemistry to produce and transport ozone. The problem is challenging due to the inherent non-linearity of the photochemistry at all spatial scales, the difficulties in simultaneously representing atmospheric fluid dynamics at different scales within a numerical model, and the complex geographic and temporal dynamics of the economics of electricity markets and distributed energy demand and supply.

Benefits

The benefit to society that DG would help to achieve, viz. a stable, guaranteed electricity supply at a reasonable retail cost is obvious. However, regulation of how, when and where to situate DG plants should take into consideration the incremental cost of higher atmospheric ozone concentrations. This may result both in severe health and welfare impacts on residents and in the loss of billions in federal funds. Studies based on sound economics and physical science principles would greatly help toward making effective regulations in this area.

Responsiveness to CEC Goals

A public interest project is one that produces benefits for residents of California, and is not adequately addressed by competitive or regulated entities. Developing improved policies and more cost effective methods for enhancing environmental quality produce benefits for the residents of California and is generally not addressed by competitive or regulated entities.

Objectives

The Environmental Energy Technologies Division at LBNL already has siginificant experience in air quality simulations (with and without DG) of Northern California including the San Joaquim Valley, using the EPA's CMAQ model.The study would be 2-pronged:

1.To simulate a few realistic cases, in which the DG emission scenario is compiled with great detail, paying attention to the geographical distribution, the technology type, and time profile of the DG, to be supplied by a demand/supply economics model developed elsewhere.

2.To simulate multiple simplified idealized cases, and parameterize the outcomes. If such a parameterization is possible, then the effect of changing input parameters e.g. electricity demand time profile, or DG generation technology could be modeled in minutes in a fast simple way without invoking the full AQ model providing a tool of great value in the area of policy and regulation. Given the

complications and non-linearities of the underlying system being parameterized, it is likely that such parameterization will be specific to particular geographical regions meteorological conditions.

Budget

2005 : 250000
2006 : 250000
Other :

Comments

Given that our simulation experience is limited to Northern and Central California, we propose to limit our study to this geographical region.

Project Concept #98: Estimating Exposure on Localized Spatial Scales from Pollutants Emitted during Distributed Generatio

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Description

The use of Distributed Electricity generation (DG) is expected to increase in the near future, driven by the introduction of dynamic electricity pricing, electricity shortages (either real or engineered), and reluctance to depend wholly on external supplies, especially following the California electricity crisis of 2001. In addition, the advent of CHP plants makes DG more cost-effective, and increases the likelihood that at least some DG will occur on a year-round or seasonal basis rather than simply at peak-demand times. However, given the air quality (AQ) crisis in the San Joaquim Valley, as well as the borderline situation in the major metrpolitan areas, it is critical to evaluate the future AQ impacts of DG. From AQ simulations we have conducted for Northern and Central California we expect the regional and local effects of DG to be very different from each other, mostly as a result of the complications of ozone chemistry. Reduced ozone levels may be seen near large NOx sources due to ozone titration by nitric oxide (but resulting in a higher ozone concentrations farther downstream.) However, this does not imply that having a large NOx producer nearby is good from an AQ point of view, as ozone is not the sole pollutant emitted. Even “clean”, natural-gas derived DG could have an impact for large (10MW) generator sizes, at short distances from the source. A study of the transport and chemistry of particulates, unburnt volatile organic compounds and toxic emissions from such sources, combined with a human exposure model is necessary to determine whether or not this is a concern.

Benefits

The benefit to society that DG would help to achieve, viz. a stable, guaranteed electricity supply at a reasonable retail cost is apparent. However, regulation of how, when and where to situate DG plants should take into consideration concentrations of particulates and possible toxics produced, given that the fuel consumed and running periods of such plants will be large. This could result in severe health impacts on downwind residents, important from a social justice standpoint.

Responsiveness to CEC Goals

A public interest project is one that produces benefits for residents of California, and is not adequately addressed by competitive or regulated entities. Developing improved policies and more cost effective methods for enhancing environmental quality produce benefits for the residents of California and is generally not addressed by competitive or regulated entities.

Objectives

1.Conduct plume simulations of DG sources utilizing spatially and temporally resolved emissions and realistic meteorological information. The “background” concentration from area, point source and motor vehicle emission would be obtained from a AQ model. This background would also provide the opportunity for plume-background chemical reactions to be simulated. These simulations would span a variety of DG technology types, unit capacities, stack heights, and meteorological conditions. In contrast with ozone studies, which are usually limited to hot summer months, meteorology from all seasons would be required for this study

2.Combine the resulting concentrations from the plumes with population distributions and population behaviour models, to determine exposure.

Budget

2005 : 150000
2006 : 150000
Other :

Project Concept #99: Reduce residential gas water heater standby losses

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Description

In California, approximately 40% of residential gas consumption (about 200 therms annually per household or 1.8 billion therms/year) is by gas water heaters statewide. In field use, about 30% of gas water heater energy consumption is to make up for standby losses, which occur mostly up the flue of gas water heaters. This results in about 530 million therms/year statewide or approximately 472 million dollars/year. There exists a potential to capture unrealized energy savings and opportunities to lower emissions by reducing gas water heater standby losses. Techniques are know that can be employed when installing a gas water heater to abate standby losses, but there is an opportunity to pursue further reductions of standby losses in the design of gas water heaters.

This project will examine several design changes to reduce the standby losses of gas water heaters to assess potential energy savings, consumer cost, emissions and safety impacts. The assessment will consist of initial screening by industry experts, laboratory and pilot field testing of prototypes, manufacturability criteria and larger scale field testing.

Benefits

When the gas water heater market in California adopts these types of water heaters, savings will be greater than 250 million therms per year. Gas water heaters emit pollutants such as NOx into the atmosphere. This reduction in gas consumption will cause a significant reduction in year-round NOx emissions. This demand reduction will also help mitigate the upward pressure on natural gas prices, thus reducing the price of natural gas to the California consumer.

Responsiveness to CEC Goals

This project will ensure the market availability of cost-effective, safe, low-emission gas water heaters with low standby losses. This will result in energy savings and environmental benefits that directly accrue to the citizens of California. The competitive market has not developed these water heaters. So far investor-owned utilities have not supported the development of this type of water heater either.

This project will ensure the market availability of cost-effective, safe water heaters with low standby losses. The competitive market has not developed these water heaters. So far investor-owned utilities have not supported the development of this type of water heaters either.

Objectives

The outcome of this project will be a cost-effective design change to gas water heaters that safely reduces standby losses at least 50%. At least one model will be offered for sale in the California market within 3 _ years of the initiation of this project.

Budget

2005 : 500000
2006 : 1000000
Other : unknown

Comments

The research team should include water heater manufacturers, market transformation experts, and service providers with extensive field experience on installing and maintaining gas water heaters in California. This team will be necessary to assure that an

Project Concept #100: High Efficiency, Low NOx Stationary Natural-Gas Engines based on HCCI

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Description

Recent rulings by the South Coast Air Quality Management District require natural gas-fired stationary engines to achieve significantly lower nitrogen oxide (NOx) emissions. Manufacturers have evaluated a wide variety of engine technologies and catalyst aftertreatment, but have found it difficult to identify and develop an approach which meets all of the regulatory requirements without compromising efficiency, adding cost and lowering reliability.

This program proposes the development of homogeneous charge compression ignition (HCCI) engines for distributed generation/co-generation applications. If successful, this application of HCCI engines will result in fuel conversion efficiency improvements that will make distributed generation/co-generation both cost and energy efficient alternatives for 200-1000kW power generation. HCCI has been proposed as the ultimate lean-burn concept because of the potential for high thermal efficiency and virtually zero emissions of nitrogen oxides (NOx) and particulate matter (PM). As in diesel engines, the fuel is exposed to a sufficiently high temperature for autoignition to occur. In contrast to diesel engines, however, a homogeneous fuel/air mixture is used. Through ultra-lean premixed operation, HCCI engines are able to match or better the high efficiencies of conventional diesel engines but with dramatically improved emissions of nitrogen oxides and particulate matter. Furthermore, much of the hardware and technology required for HCCI engines have been proven in diesel and/or SI applications. Therefore, in comparison to more far reaching alternatives such as fuel cell powerplants, HCCI is a relatively low-investment alternative engine concept.

Benefits

Distributed generation (DG) is a top priority for California because it can correct for the significant inefficiencies and disruptions associated with power generation in central stations and distributing it. The benefits of DG include the potential for significant energy savings, reduced need for infrastructure upgrades and expansion, enhanced power security via dispersing energy infrastructure resources, enhanced power quality, and energy security from increased use of natural gas resources in place of imported oil.

A significant barrier to the penetration of DG is that current natural gas engines can only achieve 30% to 35% efficiency, while efficiencies over 40% are needed to achieve significant energy and cost savings. To address this discrepancy and, therefore, enable penetration of DG, we are proposing the use of natural gas-fueled HCCI engines for DG. At the effectiveness achievable with HCCI engines (45%) the energy savings of DG (even without co-generation) becomes compelling.

Air quality benefits will also result from full implementation of the new low NOx gas engine standards combined with market penetration of gas engines for 200-1000 kW DG This development effort will also increase the likelihood that electric power consumers will get the reliability they expect from their local generation system even during central power outages.

Responsiveness to CEC Goals

The program described here would lower energy costs and increase reliability of electricity for the public by developing reliable and affordable HCCI gas engines to meet the impending low NOx standards with much higher efficiency packages. Ensuring that distributed generation is adopted and is efficient, clean and reliable is in the best interest of California consumers. Achieving the upcoming standards across the range of gas-fired engines will result in reductions in NOx emissions. However, it is critical that the approaches developed and applied are reasonable, reliable and cost effective. If existing technologies are not sufficiently advanced to meet the new standards with the appropriate level of reliability, there is a real

risk in a migration away from gas-fired engines (DG) toward central electric power station units. Such a migration could result in a negative environmental impact.

Objectives

The key objective of this project concept is the development of a low cost, low emissions HCCI gas engine approach that can be applied across a range of gas engine sizes to meet the new NOx emissions limits. The objective is to address the technical barriers that must be overcome to make HCCI technology viable for practical energy conversion applications and, consequently, capitalize on the potential benefits. This program will focus on the investigation of novel HCCI combustion sensing, actuation, and controls approaches that have yet to be fully explored in the prior art. At the conclusion of this program, the preferred sub-system embodiments will be integrated into a distributed generation HCCI engine set that is ready for in-field demonstration and testing.

The project would be structured as a partnership with Hess Microgen, a leading gas engine system manufacturer to ensure key stakeholder needs are met.

Budget

2005 : 200000
2006 : 200000
Other :

Comments

Project Concept #101: Biomass Gasification for Production of Liquid Fuels

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Description

Liquid fuels are very important to transportation and energy supply. Also, most natural gas combustion systems are also capable of burning liquid fuels (typically diesel) as a backup fuel. Diesel fuels are becoming more expensive as the level of sulfur in that fuel is being reduced to improve air quality. An alternative to production of diesel fuels from petroleum is to produce liquid hydrocarbons via gasification and the Fischer-Tropsch process applied to biomass as a renewable feedstock. Biomass conversion can be developed as a co-product of electricity generation. Such a concept could be more energy efficient than current biomass recovery technologies that burn the biomass in boilers and generate steam to recover useful energy. EPRI has conducted cursory studies that suggest coproduction facilities can be developed at an incremental cost to an electricity-only plant. This system would be beneficial to rural systems that could produce fuel for their own use or for blending with other fuels available in the area.

The program should be developed in two phases: (1)develop preliminary design and cost estimate for a biomass plant for production of electricity and Fischer-Tropsch liquid fuels; and (2) design a prototype system for demonstration in a suitable California site

Benefits

Biomass is a renewable energy source that is considered a carbon dioxide-neutral fuel. A 10 MW power plant can reduce carbon dioxide emissions by about 40 tons per year compared to generation by alternative means. The coproduction of liquid fuels from biomass will similarly reduce greenhouse gas emissions from petroleum products.

Responsiveness to CEC Goals

This project benefits the public interest because biomass, a renewable resource, does not contribute to global climate change. Energy generated conserves premium fossil fuels that would otherwise be used for electricity supply. And the small scale of the project will allow siting in a broad area across the state. The electricity produced will support local industry and the fuel produced will expand the availability of domestic liquid fuel resources. This provides greater energy security for the public.

Objectives

Biomass energy constitutes a major fraction of renewable energy currently used in Califonia. However, there are signficant resources still not being fully exploited. The development of gasification systems would provide a means of cost-effectively deploying this high-efficiency technology for distributed energy generation and production of liquid fuels in areas where the biomass materials are available, reducing transportation costs for this fuel.

Budget

2005 : 400000
2006 : 1500000
Other : 5,000,000
total in future years

Comments

GTI has conducted a variety of studies for gasification of biomass using a wide array of feedstocks over the past 20 years. We believe the technology can be developed for modular scale systems that can be readily replicated to reduce costs. Recent discu

Project Concept #102: High Temperature Fuel Cell Electricity and Hydrogen Co-Production

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Description

The concept is to research, design, develop and test a novel combined electric power and hydrogen production distributed generation idea. The concept involves using an integrated high temperature fuel cell/reformer system to produce both electricity and hydrogen. The project would use an existing commercial carbonate fuel cell plant with integrated reformer as the starting point for the research. Modifications will be made to this commercial fuel cell system to allow significant hydrogen production in addition to electricity. The hydrogen produced would be sent to hydrogen purification, compression, and storage facilities. The local co-production of these high value products (electricity and hydrogen) can be made on-site in varying relative amounts to maximize capacity factor and income in a very efficient and environmentally friendly manner. The primary goal will be to demonstrate that hydrogen and electricity can be locally co-produced in both an environmentally sensitive and efficient manner.

Benefits

The project would demonstrate that electricity can be produced with emissions that are well below the 2007 emissions standards for Distributed Generation proposed by the California Air Resources Board. Note that FuelCell Energy has already certified its high temperature fuel cell technology to meet the 2007 emissions standards.

In addition, the project will show that hydrogen can be synergistically produced using a high temperature fuel cell with minimal additional energy required or emissions produced.

The project will demonstrate that emissions associated with hydrogen transport can be mitigated through use of the local hydrogen co-production strategy.

The project can quantify emissions and energy savings in comparison to traditional electricity and hydrogen production and delivery means.

The concept could prove to be one of the most energy efficient and environmentally sensitive means of introducing the hydrogen economy.

Responsiveness to CEC Goals

The proposed effort is directed towards developing science and technology that could improve efficiency and reduce emissions from electric generation in California. In addition, the concept may also contribute to reducing emissions associated with automotive emissions by providing a concept that could locally produce hydrogen for fuel cell vehicles in the future (mitigating emissions associated with hydrogen production and transport). These benefits would certainly accrue to California citizens in the form of less expensive electricity and hydrogen fuel costs, as well as reduced emissions if the technology could be commercialized. Secondly, the authors are not aware of any siginficant commercial or regulatory agency effort to advance this hydrogen co-production concept. As a result, this effort meets the definition of "public interest" energy research.

Objectives

Research to conceptualize systems, and develop the theoretical basis for the hydrogen co-production concept.

Systems integration concepts and thermodynamic analyses for design of the proof-of-concept facility and future products that use the local hydrogen co-production concept.

Proof of the distributed hydrogen co-production concept by modification of an existing high temperature fuel cell power plant and integration with hydrogen separations and storage equipment.

Environmental analyses comparing the criteria pollutant emissions, efficiency, and carbon dioxide emissions associate with the local hydrogen co-production concept compared to traditional electricity and hydrogen production and delivery technologies.

Economic analyses to project the potential cost of electricity and cost of hydrogen using the local co-production of hydrogen concept.

Budget

2005 : 1200000
2006 : 650000
Other : 300000

Comments

Project Concept #103: Ignition Enhancement of Natural Gas by in-situ Produced C2 Additives for HCCI Applications

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Description

Recently, the Homogeneous Charge Compression Ignition (HCCI) engine has attracted attention. In HCCI engines, a homogeneous mixture is introduced into the cylinder, and is subsequently compressed until ignited. The advantage of HCCI engines is reduced soot and NOx emissions, while maintaining high efficiency by burning lean, homogeneous mixtures. There are still challenges associated with the operation of HCCI engines, like high emissions of unburned hydrocarbons (UHC) and uncontrollable ignition timing. The problem of UHC emissions is minor and can be solved with exhaust gas after-treatment. Controlling the auto-ignition timing over a range of loads and speeds, on the other hand, presents a serious problem, since in HCCI there is no direct control over the auto-ignition process. A potential strategy to overcome this issue is to reduce the mixture ignition delay time in order to achieve better control.

Among all hydrocarbon fuels, natural gas (NG) results in the lowest emissions. The benefits of NG combustion are significant under lean-burning. Thus, it is well-suited for HCCI. However, compared to other fuels like diesel and gasoline, NG has proven difficult to ignite, due to its high auto-ignition temperature. To overcome this, we propose to add to the NG in situ generated C2-hydrocarbons, whose C-C bonds prove much easier to break than the C-H bonds in CH4, and, therefore, exhibit greatly improved ignition characteristics. This is accomplished through the use of oxidative methane coupling (OCM) reactor for the production of C2 species, mainly C2H4 and C2H6.

In this proposed study the combustion characteristics of the OCM reactor mixture will be investigated under conditions relevant to HCCI. The ignition chemistry will be studied through ignition delay time calculations and flame ignition experiments under a wide range of temperatures and pressures. Several potential mechanisms will be considered and (partially) validated through comparisons with the experimental results. The eventual goal is to prove that HCCI of NG through the addition of in situ generated C2 additives is feasible.

Benefits

The success of this research will have a broad impact on the development of a new generation of NG engines. These include HCCI, dual-fuel gas, and converted compression ignition (CI) engines, with potentially much better efficiency and pollutant characteristics than the existing spark ignition (SI) NG engines. As the first stage, the HCCI natural gas engine will be selected to be the platform for the application of the C2 ignition enhancement concept. Successful implementation of the HCCI operation, resulting from successful ignition timing control and lower ignition temperature due to the C2 additives has the potential of revolutionizing distributed power generation through ultra-low NOx emissions, as well as high fuel efficiency.

Responsiveness to CEC Goals

The project provides the following public benefits:

a. The focus of this project is addressing some of the technical challenges currently facing NG HCCI engines. These engines are highly efficient and produce minimal emissions. Making their operation feasible will have significant benefits to people of California.

b. In the future HCCI engines may be used to combust renewable methane sources (i.e. landfill gas), thus turning current waste-products into usable energy.

Objectives

Objective 1: Determine the ignition characteristic of premixed CH4/additive/air mixtures for the individual additives experimentally and numerically at pressures ranging from 1-8 atm, and at elevated temperatures.

Objective 2: Determine the ignition characteristic of mixtures resulting from OCM reactors experimentally and numerically for the same conditions as in Objective 1.

Objective 3: Determine the pollutant formation characteristics of such mixtures with particular emphasis on NOx emissions. Quantify the technology potential for attaining NOx emissions in the single-digit ppm range.

Objective 4: Determine the potential of the C2 addition enhancement concept for improving the ignition control of HCCI natural gas engines.

Budget

2005 : 150000
2006 : 120000
Other :

Comments

Project Concept #104: Reducing natural gas use and simultaneously improving indoor air quality

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Description

Old gas appliances are common in California houses. They tend to be energy inefficient and are frequently a source of indoor air pollutants including carbon monoxide, nitrogen dioxide, fine and ultrafine particles which may contain toxic compunds, and excessive moisture. These pollutants increase the risks of adverse health effects ranging from death from carbon monoxide poisioning to increased respiratory illnesses in children. Recent research also points to substantial previously unrecognized health risks from ultrafine particles, which are produced during gas combustion. These pollutants are released to indoors in old appliances due to cracked heat exchangers, faulty naturally-aspirated combustion vents, backdrafting, unvented pilot lights, and poor appliance tuning. We hypothesize that modern gas appliances, while saving energy, will have greatly reduced emissions of these pollutants to indoors because they have forced combusion, uncracked heat exchangers, electronic ignition systems, and better tuning. A program of research is needed to quantify the opportunity for simultaneous energy savings and IAQ improvements associated with modern gas appliances.

Benefits

The anticipated benefits of this research are reduced natural gas consumption with associated outdoor environmental benefits, reduced energy costs to consumers, improved indoor air quality and improved health.

Responsiveness to CEC Goals

This project is in the public interest. It would advance scientific knowledge about the emissions from gas appliances (which have not been studied significantly in the last decade) and about the environmental benefits of modern appliances. California's citizens would benefit from the reduced energy costs, improved indoor air quality, and improved health. This project requires public funding. Industry is very unlikely to support such research because the benefits will be a public good than can not be captured by individual industrial sponsors. In addition, the gas industry has tended to avoid research that might increase awareness of the risks of combustion appliances.

Objectives

The key objectives of this research are to:

a) quantify the opportuntity for simultaneous energy savings and indoor air quality improvments from the use of modern energy efficient gas appliances

b) Develop new knowledge that provides an incentive for more rapid replacement of old inefficient appliances

c) reduce natural gas consumption

d) improve indoor air quality and people's health

Budget

2005 : 500000
2006 : 500000
Other : 500000

Comments

Project Concept #105: LNG Terminal Design and Safety

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Description

With several LNG regasification terminals proposed to serve the California market, LNG could become an important source of natural gas for meeting California's gas needs. Liquefied Natural Gas (LNG) is a cryogenic or liquid form of natural gas which is cooled for easier transportation over long distances. An essential part of the California Energy Commission's (CEC) natural gas research program must address the design and safety of proposed LNG terminals. One of the main outcomes of this proposed CEC natural gas research program is to provide CEC staff with broad knowledge about the safety and environmental standards of proposed LNG terminals. The research would cover:

1. Evaluation of the engineering and design information provided by LNG terminal developers and operators.
2. Review of criteria used to determine reliable and safe operations, and the adequacy of operating and maintenance practices proposed by LNG terminal developers and operators.
3. Review of design spill criteria used to establish thermal radiation and flammable vapor exclusion zones at LNG facilities.
4. Assessment of additional safety features that could be put in place.
5. Assessment of international construction, operation, and maintenance standards and/or regulations, e.g., in Japan or Europe, that offer better protection and/or operating and maintenance measures/standards
6. Evaluation of the adequacy of engineering, safety, and environmental reports provided by LNG operators during construction and operation of an LNG terminal.
7. Development of a cryogenic design and inspection manual that would be used by CEC staff during the design review of LNG facilities and subsequently used to evaluate facility operations; including whether there are additional facets of plant operations, maintenance procedures, or procedures that should be examined

Benefits

The project will objectively assess the safety and environmental impact of proposed LNG terminals and enable Californians to objectively assess the risks and benefits associated with the terminals. The risks are mainly perceived to be a catastrophic failure of the terminal and impact to the environment of terminal construction and operation. The benefits would be the provision of additional natural gas supplies to replace flat to declining production from California's traditional supply basins in the Southwestern states and Canada, a likely reduction of current high gas prices, and a diversification of California's energy supply. An assessment of the environmental impact of LNG terminals will help to quantify the benefits to the environment from burning relatively clean natural gas.

Responsiveness to CEC Goals

The research will benefit California citizens by providing an independent review of LNG facility design. The work should be a collaboration of independent experts in the field of cryogenic design and facility failure consequences. The research will support policy makers who have called for much more detailed analysis of accidental or intentional events that could result in a catastrophic failure of an LNG regasification facility, and subsequent consequences of such a failure.

Objectives

Early attempts at siting onshore and offshore regasification terminals in Southern California have met with significant local resistance due to increased safety/security concerns, given the present global political environment and general perceptions about the properties of LNG. The suggested project will provide a baseline of information to address concerns that communities adjacent to proposed LNG terminals, state

officials, and others have about the safety of LNG terminals. It will also address the consequences of a release of LNG (either by accident or through sabotage) and methods for mitigating any such consequences.

The project will provide objective standards for evaluating the engineering design, safety, and environmental impact of a proposed LNG terminal. It will provide a review of safety standards set by international regulatory bodies, assess their effectiveness and suitability for the California market, and propose any additional steps that California should take to ensure that LNG terminals comply with California regulations.

Budget

2005 : 200000
2006 :
Other :

Comments

Project Concept #106: Demonstration of Solid Oxide Fuel Cell Operation on Natural Gas

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Description

General Electric Energy, Hybrid Power Generation Systems (HPGS), Torrance, CA recommends a project for long term testing of planar solid oxide fuel cell (SOFC) stacks on natural gas to accelerate the development of SOFC technology. Systems containing SOFC fuel cells have the potential to provide cost effective, highly efficient, and clean power generation in a variety of sizes and applications ranging from 500-W battery chargers to multi-megawatt centralized power generation plants. HPGS envisions SOFC-gas turbine (GT) hybrid systems initially in the megawatt size power range, that would be ideal for distributed and dispersed power generation needs in the next decade.

The SOFC is an all solid-state fuel cell with its electro-chemical reaction being the basis for its attractive efficiency and emission features. At present, the planar SOFC is still in an early stage of development. Key technical development areas include demonstration of operation with desired performance characteristics under various operating conditions, life, degradation, reliability, and cost. This proposed project will focus on testing kW-class SOFC stacks for extended periods of time to demonstrate life and performance with natural gas. Degradation under natural gas and other operating conditions will be determined. Performance, life, and degradation data will be used to project efficiency, emission, and cost for the SOFC systems. This project will demonstrate planar SOFCs as a highly efficient, environmentally benign, and cost competitive power generation technology for a wide range of applications in California

Benefits

SOFC-GT technology offers significant benefits to the electric power consumer. Since fuel cells convert chemical energy directly into electrical energy without the need for combustion, they offer high efficiency over a very large size range and are non-polluting. This enables the use of SOFC-GT systems in a large variety of applications. Since the basic design of fuel cell is independent of the application, the proposed effort has broad applicability, beyond just SOFC-GT applications.

The benefits of this technology to Californian citizens would include increased power generation efficiency at competitive prices, reduced pollution and green house gas emissions. An increased availability of electric power through dispersed or distributed generation would also reduce transmission and distribution congestion. Also, while the logical first step in the development of the SOFC technology is for natural gas systems, the fuel cell also offers the flexibility of using other fuel sources, including hydrogen, biomass, and landfill gas.

Since GE HPGS is based in Southern California and SOFC manufacturing and engineering is currently based in Torrance, California, the success of this technology will also increase the number of high quality and well-paid jobs in the state.

Responsiveness to CEC Goals

Recent experiences in California and the Northeastern United States have elevated the need for additional power generation capacity and for improvement of the power distribution infrastructure. Distributed or dispersed power generation using SOFC technology provides an environmentally friendly, viable, and flexible alternative to alleviate the strain on the existing and aging infrastructure: SOFC-GT systems promise the highest efficiency at competitive prices and the lowest emissions over the broadest range of plant sizes. These systems, initially in the 1MW to 10-MW size range, can meet the need for distributed and dispersed power generation applications or solutions.

The proposed SOFC stack testing is a requisite step in the development of SOFC technology. Extended testing of this technology is necessary to address the two central issues facing the technology:

cost and reliability. This test validates key design features, provides the necessary data to improve the design, reduces the cost, and evaluates its reliability.

Since SOFC technology is viewed as long-term and high risk, funding for this technology cannot be borne by private interest alone. Additional funding sources are viewed as necessary for the development and commercial introduction of this technology.

Objectives

The proposed project focuses on four main objectives:

1. Demonstrate feasibility of operating planar SOFCs on natural gas with desired performance characteristics. Project efficiency, emission, and cost of SOFC-GT systems and compare with conventional power generation technologies to demonstrate benefits.

2. Establish planar SOFCs as an advanced technology and the enabling component for future highly efficient, environmentally benign, and cost competitive electricity generation in California.

3. Support the State Energy Policy in identifying and developing reliable and reasonably priced electrical power for California.

4. Show a wide range of power generation applications and services to various sectors for planar SOFCs. These diverse uses of the SOFC along with improved efficiency and reduced emission provide significant benefits to the general public.

Budget

2005 : 1000000
2006 : 1000000
Other :

Comments

Project Concept #107: Biomass Gasification for Production of Industrial Fuels

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Description

California industrial consumers require gaseous fuels at reasonable prices for the long term. To this end, natural gas suppliers and industrial consumers of natural gas such as chemical, refining, pharmaceuticals, metals, and glass plants need alternative sources of energy. Gasification of renewable biomass resources can provide an effective fuel for industry to provide direct process heating or in boilers to produce steam. R&D is needed to develop small scale biomass gasification facilities for fuel generation at industrial plants.

Benefits

Biomass is a renewable energy source that is considered a carbon dioxide-neutral fuel. Combustion of biomass can be accomplished with similar emissions as natural gas.

Responsiveness to CEC Goals

This project benefits the ratepayers because (a) biomass is a renewable energy source and does not contribute to global climate change. Energy generated conserves premium fossil fuels that would otherwise be used for this purpose;(b) The small scale of the project will allow siting of a facility in a broad area across the state. This provides greater energy security for Californians; (c) Bio-derived syngas combustion can be accomplished with lower emissions than with direct combustion of biomass materials.

Objectives

Biomass energy constitutes a major fraction of renewable energy currently used in California. However, there are significant resources still not being fully exploited. The development of gasification systems would provide a means of cost effectively deploying this high efficiency technology for production of industrial fuels in areas where the biomass materials are available, thus reducing transportation costs for the fuel.

Budget

2005 : 200,000 (feasibility study)
2006 : 0
Other : 5,000,000
total in future years

Comments

Project Concept #108: Emission Impacts of High-Btu LNG on Industrial Burners

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Description

Several Pacific Coast LNG projects are going through the permitting process and one or more are likely to delivering natural gas to California in the future. Depending on its source and the level of processing where it is delivered, LNG can have higher Wobbe Number and heating value than the current supplies of natural gas. Southern California Gas Co. reports that this could cause sudden changes in heating value for their customers from 1020 Btu/scf (HHV), the normal average heating value, to 1150 Btu/scf, the highest level allowed by the SoCalGas tariff, and back. With few exceptions, combustion equipment in California do not have the capability of detecting the fuel changes and adjusting air/fuel ratios.

This project would go to locations with typical industrial combustion equipment to determine the emissions and operational impacts of the high Btu natural gas, by supplementing the normal natural gas fuel with up to 8% LPG by volume.

Benefits

As previously explained, the project would identify emission, safety and operational problems caused by fluctuations in gas quality due to LNG supplied to California, and allow informed decisions about any needed gas quality regulations for LNG.

Responsiveness to CEC Goals

Advances science or technology

This project would provide knowledge of the impact of high-Btu natural gas on industrial combustion equipment. It would allow regulators gas distributors to make informed decisions about gas quality requirements to be put on LNG.

Research benefits accrue to California citizens

The research could lead to improved safety and emissions of combustion equipment burning LNG in California.

The research is not adequately addressed by competitive or regulated entities

Southern California Gas Co. is conducting testing of smaller combustion equipment found in residential and commercial locations, but they are purposely avoiding industrial equipment. Small equipment is generally natural draft and burns with large amounts of excess air. They should be more tolerant of the higher combustion air requirements of high-Btu gas. Industrial equipment is generally forced draft and burns closer to stoichiometric conditions for improved efficiency. They are likely to be less tolerant of high-Btu gas. A combustion device operating with 2-3% excess air with normal natural gas could have an inadequate amount of combustion air with the high-Btu gas.

Objectives

The objectives of the program would be to determine the impacts of the higher Btu fuel on:

- Emissions of NOx, CO, unburned HC, and flue gas O2.
- Safety of the combustion equipment.
- Combustion and thermal efficiency
- Process parameters
- Product characteristics

Budget

2005 : 75000 2006 : 75000 Other :

Project Concept #109: Low Cost, Reliable Low NOx burner design for water heaters

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Description

Recent rulings by the South Coast Air Quality Management District require natural gas-fired water heaters to achieve significantly lower nitrogen oxide (NOx) emissions than current requirements. Starting on January 1, 2006, a phase-in program beginning with water heaters sized 50 gallons or less will set water heater NOx emission limits at 10 ng/J, down from the current standard of 20 ng/J. The effective date represents a one year delay from the original date due to numerous concerns expressed by water heater manufacturers. Water Heater manufacturers are faced with three competing regulatory issues in their product development process. These are new safety standards for flammable vapor ignition resistance (FVIR), higher DOE minimum efficiency standards and these new lower NOx emissions requirement. Manufacturers have evaluated a wide variety of burners, but have found it difficult to identify and develop an approach which meets all of the regulatory requirements without compromising product integrity and reliability. The recent addition of a lint, dust, and oil test to the FVIR standard has made it particularly difficult to develop burner approaches. For example, radiant burners, a typical approach to achieving NOx reductions, tend to be easily impacted by an accumulation of lint, dust or oil.

The project suggested here is to develop a low cost, low NOx burner approach for gas-fired water heaters that will allow water heater manufacturers to meet the upcoming emissions standards without compromising the reliability and performance expected of natural gas fired water heaters. The concept envisioned is a single solution system that combines the necessary burner characteristics to achieve the appropriate levels of NOx emissions with the need to meet FVIR requirements, including the lint dust and oil test, in a package that maintains the reliability and efficiency typical of today's gas-fired water heaters.

Benefits

SCAQMD projects full implementation of the new low NOx water heater standards will eventually result in a reduction of NOx emissions of 7.2 to 8.3 tons per day. Development of a low-cost, reliable approach to allow gas-fired water heaters to meet the NOx requirement will prevent a migration to electric water heaters and a potential net negative environmental impact. This development effort will also increase the likelihood that consumers are getting the reliability they expect from their gas-fired water heater without having to pay an excessive price premium.

Responsiveness to CEC Goals

The proposed conceptual program described here would be a means to develop reliable and affordable approaches for water heater manufacturers to meet the impending low NOx standards. Ensuring that these approaches are reliable is in the best interest of California consumers. Achieving the upcoming standards across the range of gas-fired water heaters will result in reductions in NOx emissions. However, it is critical that the approaches developed and applied are reasonable, reliable and cost effective. If existing technologies are not sufficiently advanced to meet the new standards with the appropriate level of reliability, there is a real risk in a migration away from gas-fired water heaters toward electric units. Such a migration could result in a negative environmental impact.

Objectives

The key objective of this project concept is the development of a low cost, low emissions burner system approach that can be applied across a range of water heater sizes to meet the new NOx emissions limits and all the other regulatory requirements without compromising product reliability. Such a system would be capable of providing the necessary flammable vapor ignition resistance with low NOx with no negative effect on efficiency. Ideally, the project would be structured as a partnership with a burner

manufacturer and/or a water heater manufacturer to ensure key stakeholder needs are met. In summary, the main objective would be to design a manufacturable burner that meets cost and performance targets, integrate this burner design into an overall water heater combustion system and demonstrate the necessary performance attributes through extensive verification and reliability testing. Integrating burner and water heater manufacturers into the development process will help to increase the likelihood of commercialization of the work from this project.

Budget

2005 : 500000
2006 :
Other :

Comments

Project Concept #110: Ultra-Clean and Efficient Commercial and Small Industrial Boilers

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Description

Commercial and industrial water heating in California consumed approximately 400 Mth of natural gas in 2002. As these boilers are mostly installed in urban areas, they will be subjected to very stringent air quality regulations to be implemented in areas from the North Bay continuing down to the Mexico boarder. While many boiler manufacturers are developing methods to meet these rules, some considers the cost to be prohibitively high for the smaller units. The purpose of this R&D is to develop and demonstrate a new, cost effective, highly efficiency, and ultra-clear boiler for commercial and small industrial uses. Its centerpiece is the low-swirl burner developed at Lawrence Berkeley National Laboratory. This burner is robust, simple, and amenable to mass production from conventional materials. It has been demonstrated to emit less than 5 ppm NOx and 20 ppm CO, in a 100 HP water tube boiler. Our work will focus on designing a new boiler configuration consisting of a heat exchanger with a condensing section to fully exploit the compact flame produced by this burner. It will have a significantly smaller footprint than conventional boilers because of the reduction in flame size. We also plan to include in the design provisions for burning alternate gaseous fuels (i.e. propane, refinery gases and renewable gases) and for an optional reformer for fuel treatment. We have found that through fuel treatment, the emissions can be further reduced to below 2 ppm NOx. Partnering with a boiler OEM, we shall develop and build a prototype boiler of 5 MMBtu/hr for full scale demonstration and evaluation. Knowledge gained from these activities will be encapsulated in guidelines and rules for scaling up or down to other sizes.

Benefits

A new boiler design will help Ca end users to meet air quality rules as well as saving energy. Reducing NOx 30 ppm to 5 ppm and increase system efficiency from 82 to 95% will help to reduce 500 tons of NOx emission and save 63 Mth of natural gas per year. (Estimation based on 400 Mth per year usage in California for commercial and small industrial usages).

Responsiveness to CEC Goals

This research is consistent with the CPUC critera of "public interest" in that it will benefit the California public by reducing pollutant emissions and by increasing the efficiency of natural gas use in a significant market sector. Designing a new boiler configuration and developing the guidelines and engineering rules for further development requires the understanding and synthesis of fundamental scientific knowledge on burner technology, combustion chemistry, combustion fluid mechanics, heat transfer, in chamber fluid motions and fluid properties of the process fluids. This is a scientific system development approach that is fundamentally different than the product development approach taken and embraced by competitive market R&D.

Objectives

The deliverables are a prototype boiler of 5 MMBtu/hr and design guidelines and engineering rules for scaling to smaller or larger sizes. The metrics are $5 < NOx < 9$ ppm, no more than 4 % excess O2, manufacturing cost not to exceed 20% of current products, operating cost same as current products, utilize existing controls, and improve efficiency to more than 95%.

Budget

2005 : 250000 2006 : 250000 Other : 500000

Comments Research Partner: CMC Engineering, Mountain View, CA

Project Concept #111: AquaSmart: High Performance Domestic Hot Water Systems

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Description

The goal of the AquaSmart project is to reduce demand for natural gas in the existing residential and small commercial sectors through the advancement of energy and water efficiency technologies. Community Energy Services, in conjunction with the City of Berkeley, proposes to undertake original research and analysis to serve the public interest on the energy/water efficiencies and cost-effectiveness of advanced hot water and natural gas demand reduction technologies. The research and analysis will focus on the performance and acceptance of various packages which combine super-efficient natural gas water heaters (with energy performance over Energy Factor 0.63) with super-efficient appliances and solar thermal technologies. Research into these technology characterizations, either as stand-alone energy efficiency measures or when packaged together, have yet to occur in California.

This project will advance research in the resource gains that can be achieved through energy efficiency and renewable energy measures (as has proved so successful in the electricity sector). It will add to the development of policies and programs that would encourage the large-scale adoption of energy-efficient and solar technologies in the residential and commercial sectors.

Benefits

There are currently about 12 million inefficient natural gas water heaters in California's residential sector. We estimate that super-efficient water heaters in combination with efficient appliances and solar thermal could reduce natural gas demand for existing households by 30% to 60%. If California turned over its existing inefficient domestic hot water systems to the combinations of technologies investigated in this project, the natural gas savings are ~1,000 Mth/year. This would be equivalent to avoiding 1Bcf/day or the annual output of one LNG facility.

Responsiveness to CEC Goals

Research into these types of technology characterizations have yet to occur in California.This research and analysis will have the following implications for State Energy policy:

* Potential for PGC Fund incentives for super efficient natural gas water heaters, beyond current programs
* Development of fuel switching policy and incentives from natural gas to solar water heating
* Development of new minimum performance standards under Title 20
* Refinements in statewide and third party energy efficiency program offerings to include packages of technologies aimed at reducing natural gas use for hot water supply

Objectives

1) Measurements on the performance and cost-effectiveness of state-of-the-art domestic hot water technologies in the existing residential and small commercial markets.

2) Field test of the customer acceptance of these technologies and retrofit packages in California's existing residential and small commercial markets.

Budget

2005 : 100000
2006 : 75000
Other :

Comments

Project Concept #112: Zero-Emission Biomass Gasification Power Project

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Description

This project proposes to replace the natural gas fuel to a nominal 5 MW power plant with a stream of synthetic gas produced from the gasification of biomass material and/or municipal solid waste (MSW). In doing so, the project will generate up to 3 MW of baseload, renewable, zero emission power, and will demonstrate a technology representing a "negative carbon cycle".

This project will use much of the equipment and infrastructure already existing at a 5 MW biomass plant, which is currently being repowered as a zero-emission natural gas power plant. Currently activities are supported with funding from the California Energy Commission PIER program, the US Department of Energy, Air Liquide, Mirant Corporation, and Clean Energy Systems, Inc.

This project will demonstrate on a commercial scale the use of biomass fuels to produce power without any atmospheric emissions, thereby eliminating one of the chief obstacles to broader use of biomass energy resources. More information can be found on the current project at www.cleanenergysystems.com.

Benefits

Anticipated benefits are describd above, and will be quantified during the proposal preparation phase. Primary benefits are reduced air pollution and greater use of biomass fuels. Plant efficiencies of 40% to 45% are expected for integrated gasification/zero-emission power plants using biomass fuels.

Responsiveness to CEC Goals

This project will facilitate reductions in air pollution from biomass power plants, reductions in the need for field burning of agricultural waste, reductions in emissions of greenhouse gases, and reductions in all other atmospheric pollutants.

Objectives

Demonstration on a commercial scale of biomass gasification integrated with an oxy-fuel combustion process to produce power from biomass fuels without pollution. Suitable scale for this technology will be 5 MW to 50 MW.

Budget

2005 : 750000
2006 : 1000000
Other : 250000

Comments

Funding would be used to install a new gasification and gas cleanup system. The power cycle and material handling systems are already in place.

Project Concept #113: Demonstration of Low-Cost Continuous Emission Monitoring of RICE Generators

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Description

SCAQMD is finding high non-compliance rates for reciprocating internal combustion engine (RICE) electric generators equipped with 3-way catalysts to control emissions. These are engines smaller than 1000 HP that are not required to have continuous emission monitoring equipment and are only required to do periodic source tests. They pass their scheduled, periodic tests but do not pass when SCAQMD conducts unannounced tests with a portable analyzer.

This project would be a demonstration project to determine the feasibility and costs of using lower cost emission analyzers, similar to the portable analyzers now in use, to continuously measure and record emissions of NOx and CO, corrected to 15% O2. Equipment from several manufacturers could be tested side-by-side for durability and accuracy.

Benefits

If successful, the project could lead to cost-effective means to reduce excess emissions from RICE generators.

Responsiveness to CEC Goals

Advances science or technology

The project could lead to improved monitoring of RICE generators and reduced emissions.

Research benefits accrue to California citizens

There are thousands of small RICE generators polluting the air in California. If successful, this project could lead to better air quality for Californians.

The research is not adequately addressed by competitive or regulated entities

We are not aware of similar research elsewhere.

Objectives

To improve the emissions of small RICE generators by better monitoring with low-cost emission analyzers.

Budget

2005 : 30000
2006 : 15000
Other :

Comments

Project Concept #114: Seismic Hazard Analysis and Risk Reduction for the California Natural Gas Distribution System

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Description

The Southern California Earthquake Center (SCEC) coordinates a broad research program on seismic hazard analysis (SHA) across more than 50 universities and research organizations, including most California universities, three offices of the USGS, and California Geological Survey (CGS), and it partners with many other California organizations (e.g., PEER, CEA, OES) in studies to reduce earthquake risk. SCEC proposes to focus this program with a well-defined set of activities directed at reducing risk to California's natural gas supply and distribution system. One example is a field-based effort to estimate the displacements and recurrence times of large earthquakes at places where large gas pipelines cross major faults. Based on present knowledge, the 30-yr conditional probabilities for rupture of the San Andreas fault south of Parkfield range from 20 to 60%, depending on assumptions. This project will reduce these uncertainties, and it will also determine the variability of slip at selected points on the fault, which is poorly constrained by existing data. As a second example, we will leverage on SCEC research regarding the variability of ground shaking caused by complex geologic structures, such as basin resonances and basin-edge effects. We will use our existing models to do simulations on the ground motions expected across the pipeline system and at critical facilities (such as proposed LNG terminals) for a set of high-probability earthquake scenarios. Finally, working with engineering partners, we will extend these simulations to include non-linear site effects and structural response. Our focus will be to build scenarios that can predict how the damage caused by strong ground motions would be distributed across the entire natural gas supply and distribution system, not just a single component.

Benefits

FEMA estimates that the earthquake risk in California constitutes about three-quarters of the national total. Earthquakes are clearly the most dangerous natural threat to California's natural gas system. The proposed project will provide critical knowledge for improved decision-making. This will increase public safety and the security of California's natural gas supply and distribution system.

Responsiveness to CEC Goals

The proposed project satisfies the basic CPUC criteria adopted in D.04-08-010. It focuses on the exposure of the natural gas supply and distribution system to California's earthquake threat, which poses both environmental and socio-economic problems. Disruption of the system by major earthquakes has the potential to cause major environmental damage, economic loss, and social hardship. Products developed by this project will help to reduce losses and save lives. Because SCEC is funded by both the National Science Foundation and U. S. Geological Survey to conduct a broad-based research program on system-level earthquake science, our participation provides opportunities for leveraging CEC resources against federal resources. SCEC is itself a large collaboration involving more than 400 scientists in 50 universities and research organizations, and it partners with many other California organizations (e.g., PEER, CEA, OES) in studies to reduce earthquake risk.

Objectives

Key objectives are (1) to obtain better information on the frequency of earthquake displacements on major faults that could be directly applied to pipeline design, (2) to use end-to-end ("rupture-to-rivets") simulations to reduce earthquake risk to California's natural gas supply and distribution system, and (3) to connect the California Public Interest Gas R&D Program to broader statewide efforts to characterize system-level hazards, both natural and man-made. With respect to objective (1) we note that the successful performance of the Alaska pipeline during the 2002 Denali earthquake demonstrates the value of knowing the magnitude and amount of displacement associated with earthquakes on active faults.

Budget

2005 : 500000
2006 : 500000
Other : 1,500,000
(36 mo.)

Comments

SCEC will work with the California Energy Commission and engage stakeholders to refine the project concept and objectives to best respond to the overall CPUC criteria. SCEC's mission is to gather new information about earthquakes in California, integrate

Project Concept #115: Impact of Gas Composition on Reciprocating Engine Performance and Emissions

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Description

The chemical composition of natural gas in California is expected to become more variable as traditional supplies are augmented by LNG imports and by additional renewable biogas sources that are encouraged in the State Energy Plan. Reciprocating engines operating in California normally have very restrictive emissions limits. These units can be very sensitive to the fuel gas chemical composition. A comprehensive evaluation of the effects of varying fuel gas composition on engines used in distributed generation and in pipeline gas compression is needed to determine the nature of hardware and control modifications this equipment may require to remain in compliance, and to maintain peak operating performance.A facility for controlling and varying fuel gas composition, and for precisely determining the effects on engine performance and emissions is required to properly conduct such studies. The Engines & Energy Conversion Laboratory at Colorado State University is the logical location to install such gas blending capability, since an array of the engines typically found in distributed generation applications and the pipeline compressor engines used throughout California are already installed there. This is the only independent location known with such established large engine infrastructure. In addition CSU has extensive precision emissions measurement systems in-place, and a complete array of engine performance monitoring.

Benefits

Advanced reciprocating, internal combustion engines are a cost-effective, reliable and environmentally sound method for producing distributed generation capacity, and are likely to remain prominent for the next 20 years. A comprehensive understanding of bio-gas and pipeline gas is necessary to support the ARICE goals 1) a cost of electricity that is competitive with grid-supplied electrical energy, 2) low environmental impact, 3) high reliability and 4) market connection. Pipeline compressor engine performance and emissions compliance is fundamental to maintaining adequate gas service to all customer classes in California. Knowledge of the effects of these varying fuel gases on compressor engines will reduce the chance of outages due to extended maintenance, unit failures or emissions excursions. During peak demand periods, the cost of compressor outages and reduced throughput can be extremely high as gas deliveries may be curtailed.

Responsiveness to CEC Goals

Action III of the State Energy Action Plan is “Ensure Reliable, Affordable Electricity Generation”, and fuel composition is critical to this requirement to the extent it may affect mechanical outages and air emissions compliance. Action V, “Promote Customer and Utility Owned Distributed Generation” includes a list of seven (7) criteria. This project concept meets at least two (2) of these criteria: V.1, “Promote clean, small generation resources located at load centers” and V.4, “Develop standards so that renewable distributed generation may participate in the Renewable Portfolio Standard program”. In addition, the penetration and wide use of renewable gaseous fuels will be enhanced if this equipment can be made to routinely tolerate these fuels, thus supporting State renewable portfolio objectives.As the pipeline industry has an expressed interest in this issue as it involves compressor engines, this project also affords CEC an opportunity to collaborate with industry pipeline R&D programs (see additional comments below), and obtain incremental cofunding. It is not likely that the PRCI R&D program will support this work alone in 2005, due to significant budget pressures.

Objectives

Documentation of the effects of varying fuel gas composition on engine performance and emissions. This information can be used to identify necessary modifications to existing equipment enabling it to remain in-service and in-compliance, or to ensure that fuel gas supplies comply with a specified range of

quality. In addition to overall efficiency and output, gas composition may affect required maintenance intervals and component lives – including sensors used for control and monitoring.

Budget

2005 : 1000000
2006 : 500000
Other : 800000

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #116: Development of Guidelines for the Distribution of Imported Liquefied Natural Gas (LNG) Compositions

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Description

In the U.S., natural gas demand is growing faster than production. This imbalance in supply and demand has resulted in significant price volatility. LNG imports are expected to play a critical role in closing the gap between natural gas supply and demand. The chemical compositions of the imported LNGs can vary from the domestic gases supplied in North America. Compared to domestic natural gases, these LNGs may have higher levels of ethane, propane and butane. The differences in the chemical composition of the imported LNGs can have an impact on the performance of combustion equipment, such as residential gas-fired appliances, natural gas engines, gas turbines at power generation facilities, and industrial combustion systems. The LNGs are also likely to affect the operation and efficiency of industrial facilities that use natural gas as feedstock, such as hydrogen production facilities and LNG peakshaving plants.

Residential appliances are often the limiting application when evaluating the impact of imported LNGs. A small subset of the appliance population is likely to be sensitive to changes in the gas composition due to specific burner designs as well as adjustment and maintenance of the equipment. These appliances are likely to exhibit elevated CO emissions when operated with imported LNGs and therefore pose a significant health risk to consumers.

Prior to distribution, imported LNGs can be modified with the injection of nitrogen, air or domestic gas, to achieve acceptable performance in sensitive combustion equipment. There is a critical need to understand the changes in the performance of gas-fired combustion equipment due to the projected shift in the natural gas supply. This will help in establishing guidelines for the safe accommodation of the imported LNGs.

Benefits

The identification of alternative sources of natural gas supply is a top priority for California because it can mitigate the volatility in the natural gas prices. With natural gas use increasing, the use of imported LNGs will create a reliable natural gas supply for Californians at a reasonable price. However, it will be critical to evaluate the risks posed by the imported LNGs, especially in residential appliances. The benefits of conducting an interchangeability assessment and developing guidelines for the distribution of LNGs are the lower health risks for consumers, and the safe operation of natural-gas-based combustion equipment and industrial facilities in California.

Responsiveness to CEC Goals

One of the six actions identified to be of critical importance under the State of California's Energy Action Plan is to "ensure reliable supply of reasonably priced natural gas". California's demand for natural gas is increasing driven mainly by the increased use of natural gas in the power generation industry. Specifically, the action plan references a need to evaluate the benefits of increasing the state's natural gas supply options, such as the use of liquefied natural gas. The proposed interchangeability assessment and the development of guidelines for the safe accommodation of LNGs is a key element of this type of benefits analysis.

Objectives

The key objective of the proposed project is the development of guidelines for the safe accommodation of imported LNG compositions in California. The focus of the project will be the impact on the operation of end-use equipment such as residential appliances, natural gas engines, gas turbines, industrial burners, hydrogen production facilities and LNG peakshaving plants. Appliance population characteristics, historical gas compositions, maintenance practices, and industrial applications in various service areas will

be examined. In-house software tools, that use analytical techniques based on combustion theory and experimental data, will be used to assess the interchangeability issues associated with the introduction of imported LNGs. A field survey will be conducted to identify appliances that show elevated CO emissions. Some of these sensitive appliances will be selected for further testing in our laboratories using typical LNG compositions.

The combined results from the analytical analyses and the experimental testing will be used to develop blending requirements for several LNG compositions. Finally, a set of guidelines will be created that may be used by gas distribution companies to evaluate the acceptability of a particular LNG supply and determine LNG modification requirements prior to distribution.

Budget

2005 : 950000
2006 :
Other :

Comments

Project Concept #117: Low Cost, Reliable Low NOx burner design for water heaters

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Description

Recent rulings by the South Coast Air Quality Management District require natural gas-fired water heaters to achieve significantly lower nitrogen oxide (NOx) emissions than current requirements. Starting on January 1, 2006, a phase-in program beginning with water heaters sized 50 gallons or less will set water heater NOx emission limits at 10 ng/J, down from the current standard of 20 ng/J. The effective date represents a one year delay from the original date due to numerous concerns expressed by water heater manufacturers. Water Heater manufacturers are faced with three competing regulatory issues in their product development process. These are new safety standards for flammable vapor ignition resistance (FVIR), higher DOE minimum efficiency standards and these new lower NOx emissions requirement. Manufacturers have evaluated a wide variety of burners, but have found it difficult to identify and develop an approach which meets all of the regulatory requirements without compromising product integrity and reliability. The recent addition of a lint, dust, and oil test to the FVIR standard has made it particularly difficult to develop burner approaches. For example, radiant burners, a typical approach to achieving NOx reductions, tend to be easily impacted by an accumulation of lint, dust or oil.

The project suggested here is to develop a low cost, low NOx burner approach for gas-fired water heaters that will allow water heater manufacturers to meet the upcoming emissions standards without compromising the reliability and performance expected of natural gas fired water heaters. The concept envisioned is a single solution system that combines the necessary burner characteristics to achieve the appropriate levels of NOx emissions with the need to meet FVIR requirements, including the lint dust and oil test, in a package that maintains the reliability and efficiency typical of today's gas-fired water heaters.

Benefits

SCAQMD projects full implementation of the new low NOx water heater standards will eventually result in a reduction of NOx emissions of 7.2 to 8.3 tons per day. Development of a low-cost, reliable approach to allow gas-fired water heaters to meet the NOx requirement will prevent a migration to electric water heaters and a potential net negative environmental impact. This development effort will also increase the likelihood that consumers are getting the reliability they expect from their gas-fired water heater without having to pay an excessive price premium.

Responsiveness to CEC Goals

The proposed conceptual program described here would be a means to develop reliable and affordable approaches for water heater manufacturers to meet the impending low NOx standards. Ensuring that these approaches are reliable is in the best interest of California consumers. Achieving the upcoming standards across the range of gas-fired water heaters will result in reductions in NOx emissions. However, it is critical that the approaches developed and applied are reasonable, reliable and cost effective. If existing technologies are not sufficiently advanced to meet the new standards with the appropriate level of reliability, there is a real risk in a migration away from gas-fired water heaters toward electric units. Such a migration could result in a negative environmental impact.

Objectives

The key objective of this project concept is the development of a low cost, low emissions burner system approach that can be applied across a range of water heater sizes to meet the new NOx emissions limits and all the other regulatory requirements without compromising product reliability. Such a system would be capable of providing the necessary flammable vapor ignition resistance with low NOx with no negative effect on efficiency. Ideally, the project would be structured as a partnership with a burner

manufacturer and/or a water heater manufacturer to ensure key stakeholder needs are met. In summary, the main objective would be to design a manufacturable burner that meets cost and performance targets, integrate this burner design into an overall water heater combustion system and demonstrate the necessary performance attributes through extensive verification and reliability testing. Integrating burner and water heater manufacturers into the development process will help to increase the likelihood of commercialization of the work from this project.

Budget

2005 : 500000
2006 :
Other :

Comments

Project Concept #118: Maximum Safe Loads On Buried Pipelines

Pipeline Research Council International, Inc. (PRCI), Potential sponsor
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Description

Buried pipelines can be subjected to a wide variety of mechanical loads due to their location in congested areas, used of heavy equipment for farming, transportation and construction, and proximity to other infrastructure. Traditional design and evaluation guidelines adequately address the majority of these situations. However, there are a number of unique or "non-typical" conditions that do occur with some frequency, can lead to larger than anticipated stresses within the pipe, and are not addressed by existing design and engineering tools. These conditions include shallow buried pipes that are subjected to very large surface loads, such as those associated with heavy construction equipment, and blast loadings from construction activities that occur adjacent to existing pipeline installations. These conditions are a concern to pipeline engineers charged with the design of new systems or the evaluation of older installations where known weld defects and/or pipe wall loss due to corrosion is present. It is noteworthy that the California infrastructure contains older vintage pipeline dating back to as early as 1900.No guidance for non-typical loads on shallow buried pipes or on aged systems currently exists, and hence, new and/or modified guidelines based on comprehensive physical testing and analysis are needed so that engineers can properly design new pipelines as well as assess existing, potentially degraded installations for these non-typical loading conditions. Databases to be developed should be comprehensive, and include a range of soil types, loading combinations, and standard gas industry piping sizes. Models to be developed from the databases should be easy to use and incorporate reasonable input parameters that can be derived from operating records or field measurements. Ultimately, guidelines for industry use can be based on model results or the models themselves, and this information would be employed to design service expansions and to assess the integrity of the existing system.

Benefits

Primary benefits to be realized from the proposed study include improved safety of construction and blasting operations through proper and prioritized design and mitigation requirements, and the ability to prescribe maximum safe surface and blast loads on buried pipes that may include early vintage welds and corrosion defects. Specifically, California gas pipelines would be estimated to save $400,000 annually on avoided protective slabs, avoided in-service pipeline lowering and avoided pipeline relocation. These savings would arise from improved design and assessment criteria that enable the utilities to avoid overly-conservative actions. These savings would directly flow to gas consumers via the periodic rate-case proceedings.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to ensure continuity of gas service and safe operation, and avoid life- and property-threatening incidents. Results of the study will be directly used by pipelines within California to enhance their reliability and, therefore, would generally benefit the public. Improved design criteria will also simplify expansion projects that traverse congested and heavily travelled areas, thus reducing the overall cost of system expansion and ensuring the serviceability of this long-lived asset. These benefits flow directly to gas consumers in the form of reduced cost of transmission service and more accurate and cost-effective design tools. Both existing gas customers and incremental (new) customers would benefit. PRCI has previously sponsored work in this area that will contribute significantly to the probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

Objectives

The objective of the proposed study is development of guidelines for the assessment of the mechanical integrity of pipelines subjected to non-typical loading conditions. This objective will be met through the development of physical test databases that define the pipe stress as a function of surface and blast loadings, and corresponding load and capacity models to predict the response and remaining capacity of

new and vintage pipe and associated welds and/or corroded pipes. One approach to development of the physical test databases includes scale modeling, which if successful, will provide a validated method for replacement of costly full-scale geotechnical tests. Guidelines resulting from the study will be sufficient to address shallow burial conditions, large surface loadings and blast loadings on new and existing installations. These will be used by pipeline operators, pipeline engineering firms and Code Bodies that establish operating practices on and around pipelines.

Budget

2005 : 600000
2006 : 600000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #119: Prevention and Assessment of Critical Pipeline Strains in Hazard Regions

Pipeline Research Council International, Inc. (PRCI), Potential sponsor
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Description

Current methods for designing and assessing pipelines subjected to significant ground movement (e.g., fault creep, landslides, settlement, and earthquake ground displacement) involve estimates and simplifications that are difficult to quantify since multiple soil parameters, pipe support, loading, and even pipe material properties may not be well characterized. Moreover, the interaction of the pipe with the soil and its effect on stresses developed in the pipe as it responds to such displacement is not wholly understood. In order to mitigate these uncertainties, excessive conservatism is frequently introduced that invariably results in higher design costs and maintenance protocols. However, in regions where significant displacement of the pipe has occurred and where wall loss due to corrosion is present, but has not been precisely measured, damage such as wrinkling, buckling, or premature failures (i.e., failure of the pipeline without exceeding the design pressure) may occur if appropriate remedial action is not taken. Consequently, procedures are needed for the accurate assessment of the effects of significant ground movement on the structural integrity of pipelines.

Benefits

Benefits to California citizens derive from an improved design base for new pipelines, an increased safety margin for the existing infrastructure, and reduced costs from optimizing the design and mitigation requirements necessary to maintain continuity of service and safe operations in hazard regions. These improved tools will assist operators in prioritizing maintenance response and general operations. With much of the California electricity capacity reliant upon natural gas supplies, disruptions of pipeline supply due to geological events – including precautionary pressure reductions and shut-ins pending inspection – would magnify the extent of public inconvenience, and contribute to security and safety concerns. It is the high pressure and high flow service to these consumers that are at greatest risk from these events. Further, avoiding these outages on critical pipelines within the State will avoid commodity price spikes that affect all consumers in the state, regardless of whether they are served by the affected pipeline. The price spikes experienced in California markets immediately after the El Paso Carlsbad rupture are an example of the immediate price response that can occur due to an unexpected pipeline outage.

Responsiveness to CEC Goals

The proposed program builds on a foundation of previous studies of soil-structure interaction, and excessive axial loading at earthquake fault crossings and landslide locations that have been sponsored by PRCI. This work will significantly advance the state-of-the-art understanding of these effects, with a high probability of success in achieving the stated objectives of the research at a reduced cost to the CEC due to the collaboration and potential cofunding of PRCI. This work is particularly relevant to California due to its active seismic profile, and improved practice in this area will enhance the overall State Energy policy objective of increasing the reliability of physical gas supplies throughout the State. This work is not adequately funded in the 2005 PRCI program.

Objectives

Develop improved engineering procedures for evaluating the effects of significant ground movement on the structural integrity of buried pipelines, with or without corrosion defects, and establish guidance for potential remedial action and for prioritizing maintenance operations. Most importantly, the guidelines will be used to prevent damage or premature failure of affected pipe sections by identifying critical segments of greatest susceptibility to ground movement/displacement strains and segments that require immediate remediation subsequent to such events.Key program results will include: models and methods to characterize and mitigate pipe-soil interaction effects, such as the use of geotextiles to lower pipe-soil friction resistance in earthquake fault crossings, determination of the relationship of axial and ovality

strains to horizontal soil interactions, and centrifugal models to predict soil interaction strains for pipe movement in earthquake zones. To eliminate some of the uncertainties that are introduced by variance in soil types, methodologies and screening tools that are based on in-line inspection tools or field measurements will also be developed.

Budget

2005 : 640000
2006 : 300000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #120: Prevention of Third-Party Damage

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Description

As a result of increased public awareness and regulations, and while pipeline companies strive to meet increasing demands for their services, operators are faced with intensifying risk management challenges that must balance critical safety, reliability, and economic issues. This is especially true for pipelines located in highly populated and environmentally sensitive areas. Although gas transmission pipelines are buried in well maintained utility right-of-ways and marked with warning signs, they are sometimes damaged by construction equipment or encroaching vehicles not owned by the pipeline company. The resulting damage, referred to as third-party damage, is the major cause of damage to natural gas transmission pipelines. The Department of Transportation (DOT) Office of Pipeline Safety incident reports that from 1994 to 2004, approximately 32% of all hazardous accidents involving onshore transmission pipelines were caused by third-party damage. The 252 third-party damage incidents occurring during this period resulted in 9 deaths, 38 injuries, and costs totaling $91 million, or an average of $360,000 per incident. Because a single incident can be devastating in terms of fatalities, injuries and costs, new technologies for automated and real-time monitoring of pipeline right-of-ways are needed to assure the long-term integrity, safety and security of the nation's natural gas pipeline network.The purpose of the proposed program is to investigate, develop and demonstrate the feasibility of existing technologies for applications in right-of-way monitoring. Current techniques used for minimizing third-party damage include one-call systems, routine pipeline patrols, and periodic aerial surveillance. Such systems can be enhanced or replaced by automated and/or real-time detection systems in the form of acoustic monitoring, unmanned aerial vehicles, global position sensor equipment or fiber optics. The goal is to provide a system that can be commercialized, or is very close to commercialization, so that automated and/or real-time detection of third-party damage will reduce public and utility injuries and service interruptions, resulting in a safer, more reliable transmission infrastructure.

Benefits

Specific benefits to be derived from the proposed program include an ability to alert operators of imminent harm and to reduce the number of incidents. The benefits will be provided through improved control to avoid excavation damage, quantified evidence of the effectiveness of safety-improving measures, cost-effective solutions for monitoring pipelines to reduce mechanical damage incidents and environmental and safety consequences, an ability to easily monitor vast geographic areas in near real time, and discrimination of vehicle types for improved threat evaluation. In addition, the program seeks to supply standard acceptable practices that meet the pipeline integrity rule for addressing the threat of third-party and other damage, and improvements to procedures used in proactive planning and alternative practices to lower third-party threat.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to ensure continuity of public service and safe operation, and avoid life- and property-threatening incidents. As such, results of the study will be directly used by pipeline operators within California to enhance their reliability, and therefore, would generally benefit the public. Improved technologies for monitoring ROWs and preventing third-party damage are necessary to ensure the serviceability of this long-lived asset. These benefits flow directly to gas consumers in the form of reduced cost of transmission service and more intelligent and cost-effective monitoring tools. Both existing gas customers and incremental (new) customers would benefit.PRCI has funded nearly $640,000 in R&D projects related to the development of tools to monitor and prevent third-party damage to pipelines, and is currently supporting a gap study to identify and critically assess alternative tools and practices that may be applicable and further focus future R&D efforts in this area. Consequently, this work will contribute significantly to the probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

Objectives

The objective of the proposed program focuses on development of automated and real-time monitoring technologies and alternative practices for the prevention of impacts to pipelines. Such technologies include acoustic monitoring, unmanned aerial vehicles, global position sensor equipment and fiber optics which must be further developed and evaluated to assess their monitoring capability with respect to pipeline encroachment. Meeting the stated objective for the program will be readily facilitated by on-going work through PRCI in acoustic monitoring and the performance of a comprehensive gap analysis on new technologies. The gap analysis is aimed at identifying the most promising technologies to be pursued and providing a clear and logical path forward for subsequent research activities. In addition to selection of suitable technologies for advancement, studies resulting in quantification of the actual resistance of a pipelines' mechanical protection should be pursued to provide input for integrity methodologies and alternative practices for accurately assessing the threat arising from external force damage. Ultimately, an evaluation of the technologies and alternative methods developed should be provided via risk model(s), and on the basis of capability and cost of operation for monitoring systems.

Budget

2005 : 500000
2006 : 500000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #121: Identify and Prioritize Locations Susceptible to Internal Corrosion

Pipeline Research Council International, Inc. (PRCI), Potential sponsor
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Description

According to Office of Pipeline Safety statistics for the Year 2002, internal corrosion caused approximately 18 percent of all transmission pipeline incidents. The key to mitigation, monitoring, and ultimately, the management of internal corrosion risk is the ability to reliably target areas of potential corrosion. Once the areas have been identified, reliable monitoring tools and mitigation techniques provide the information necessary to determine risk and make maintenance decisions. Internal corrosion in dry gas lines is non-uniform; it occurs at relatively few locations with the remaining system being less affected. Internal corrosion in wet gas systems is governed by the compositions of the water and gas, and the presence of bacteria. Identification of the mechanism of corrosion and the ability to accurately monitor growth are key elements in determining optimal mitigation treatments.To ensure a safe, reliable pipeline system where internal corrosion may be present, improved methods of finding and characterizing imperfections without excavation are needed. The proposed program will focus on developing technologies and methods to assist pipeline operators in identifying locations on wet gas and dry gas systems where internal corrosion conditions could be present. The technology and methods will assist operators in targeting their monitoring and mitigation activities.

Benefits

The primary benefits to be realized from the proposed program include an improved ability to detect and assess locations of active corrosion so that proper decisions on maintenance and mitigation, and gas quality can be made, thereby saving consumers the costs associated with unnecessary excavations, inspections, and repairs, and reduce the number of excavations. If a major incident can be avoided, such as the El Paso Carlsbad failure where internal corrosion was a primary cause, the California market can avoid the gas price spikes that immediately followed that incident. Such price jumps of over $1/Mcf, at the average CA consumption rate of 6.5 Bcf/day, would save at least $6.5MM/day for every day of avoided commodity price movements due to a similar major service disruption.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to ensure continuity of public service and safe operation, and avoid life- and property-threatening incidents. As such, results of the study will be directly used by pipelines within California to enhance their reliability and therefore would generally benefit the public. Improved methods of finding and characterizing imperfections without excavation will reduce costs associated with ensuring the serviceability of this long-lived asset. These benefits flow directly to gas consumers in the form of reduced cost of transmission service and more intelligent and cost-effective design tools. Both existing gas customers and incremental (new) customers would gain. PRCI has previously sponsored work on the development of ICDA Standards and risk and dry gas methodologies that will contribute significantly to the probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

Objectives

Key objectives of the study are to develop techniques and methods to identify locations along a pipeline that are susceptible to internal corrosion, improve non-intrusive monitoring and internal corrosion rate prediction methodologies, enhance Internal Corrosion Direct Assessment (ICDA) protocols, and develop probabilistic techniques for internal corrosion data processing to rank and prioritize susceptible locations. Tools, such as nano sensors, and simple in-house test methods are to be developed to characterize potential internal corrosion sites and for determining root causes of microbiologically influenced corrosion so that intrusive monitoring and inspection techniques can be avoided, at least in a

first step evaluation. Ultimately, the technologies will form the basis for corrosion growth rate predictions, which are required to address proper re-inspection intervals and gas quality decisions, and to provide guidelines/quality standards for transportation of gas containing mixed corrosive constituents.

Budget

2005 : 520000
2006 : 300000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #122: Improve CP System Effectiveness and External Corrosion Prevention, Mitigation and Monitoring

Pipeline Research Council International, Inc. (PRCI), Potential sponsor
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Description

Cathodic Protection (CP) Shielding is a major contributor to the premature failure of pipelines and piping systems. Currently, the only reliable way to locate pipe that has suffered corrosion damage from cathodic protection shielding is through the use of in-line inspection tools. There is not a reliable above ground technique that can, with any degree of accuracy, locate corrosion damage caused by shielding. Consequently, this may be a limiting factor in the application of External Corrosion Direct Assessment (ECDA) on those pipelines or piping systems that cannot be internally inspected. It is noteworthy that external corrosion contributed about 12% of all transmission line incidents from 1994 thru 2000. Current U.S. standards used in external corrosion mitigation currently do not consider environmental corrosivity. Prior research and European standards recommend using a polarized potential of –0.95V where microbiologically induced corrosion (MIC) activity is known to exist, but aboveground measurement of such activity is not commercial. The synergistic effect of factors affecting external corrosion requires improved understanding. The potential for bacterial degradation of pipeline coatings is not understood; criteria are difficult to meet in high resistivity soils, especially where coatings have aged. In certain soil types and high resistivities, the natural corrosion rate may be relatively low indicating significant CP is not required. An overall soils corrosivity model taking into account MIC and coating degradation due to soil type and resistivity, and MIC would be extremely useful in prioritizing maintenance activities.The primary issues to be investigated this program include locating areas of coating failure caused by shielding or disbondment, optimizing CP system effectiveness as a function of the environment, and improving the effectiveness of CP measurement in the presence of stray currents. Results of such study will provide value to the pipeline industry and improve reliability by delivering methods to locate and characterize coating disbondment and imperfections, and the development of improved corrosion prevention, monitoring and mitigation systems.

Benefits

The proposed program promises to benefit consumers through a reduction in maintenance costs of existing pipelines and capital costs of new pipelines, and by helping operators to ensure a safe reliable pipeline system. Such benefits will be realized through the development of improved corrosion control systems, methods for sizing and characterizing imperfections without excavation, and protocols for the detection and mitigation of coating failures, each resulting in reduced excavation costs and fewer repairs. Additionally, costs associated with frequent in-line inspections and direct examinations will be reduced through optimization and improved monitoring of CP performance that allows for better evaluations and more accurate corrosion rate assessments, yielding longer intervals between integrity assessments. Ultimately, results of the studies will be used to develop, validate and implement standard industry recommended practices to ensure reliable performance of corrosion control systems resulting in reduced maintenance costs and increased public safety.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to ensure continuity of public service and safe operation, and avoid life- and property-threatening incidents. As such, results of the study will be directly used by pipelines within California to enhance their reliability, and therefore, would generally benefit the public. Improved understanding of CP shielding and other factors contributing to external corrosion is paramount to efforts directed at solutions necessary to ensure the serviceability of this long-lived asset. These benefits flow directly to gas consumers in the form of reduced cost of transmission service and more intelligent and cost-effective design tools. Both existing gas customers and incremental (new) customers would gain. PRCI has previously sponsored substantial and important research on coating performance, CP and CP methods to mitigate MIC, and environmental factors contributing to pipeline defects that

support a high probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

Objectives

The thrust of the proposed research program is fundamentally two-fold. First, results of the studies seek to improve the effectiveness of cathodic protection systems by enhancing design, survey techniques (e.g., above ground electrical surveys) and criteria for anode selection. Understanding and mitigating the effects of stray currents on CP, and improved corrosion control systems and methods for characterizing imperfections without excavation will reduce maintenance costs of existing pipelines and capital costs of new pipelines, and enable standardization of CP methods, techniques, materials and testing and corrosion control programs. Second, but equally important, is the development of a thorough understanding and subsequent proactive treatment of factors influencing the formation of external corrosion (e.g., coating disbondment, MIC, and environmental features), to allow for improved repair coating and coating repair systems, technical support and guidance for integrity and DA initiatives, and a reduction in corrosion control maintenance costs.

Budget

2005 : 1000000
2006 : 750000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #123: Managing Stress Corrosion Cracking (SCC)

Pipeline Research Council International, Inc. (PRCI), Potential sponsor
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Description

The supplement to ASME B31.8 on Managing System Integrity of Gas Pipelines, as well as the recently implemented Pipeline Safety Act, recognizes three methods of integrity assessment: in-line inspection (ILI), pressure testing, or direct assessment. The only ILI technique that has been able to adequately find, identify, and size stress-corrosion cracks is liquid-coupled ultrasonics, which requires that the pipe be filled with a liquid, a procedure that is far too expensive to be practical. Hydrostatic retesting has been demonstrated to be effective, but it also is expensive, and the cost effectiveness could be increased significantly if optimum intervals for retesting could be developed and customized for different areas of the pipeline where the probabilities of SCC are different. There currently is no protocol for SCC direct assessment. Therefore, there are a number of opportunities to increase the effectiveness and reduce the cost of ensuring the integrity of pipelines that have experienced or are thought to be susceptible to SCC. The purpose of this research program is to develop techniques to effectively manage SCC susceptible locations through the investigation of new methodologies for detecting SCC through in-line inspection (ILI), development of methods for prioritizing the susceptibility of pipelines to SCC, and determination of the factors leading to SCC. Results of the research will provide for a reduction in the cost and an increase of the effectiveness of hydrostatic retesting and in-line inspection (ILI) for managing high-pH and near-neutral-pH SCC. (These pH measures refer to surrounding soil chemistry.)

Benefits

The benefit of results produced in the proposed program will be primarily the development of a site-selection model for prioritizing pipe segments for SCC maintenance based upon geological and environmental features, pipe and coating characteristics, operating history, failure history, retest history, and inspection history. In addition, suitable ILI protocols and technology and that successfully inspect, locate and size SCC will be identified. The coupling of theses benefits will provide a less costly and more effective means for assuring the safe a continued operation of pipelines.If a major incident can be avoided, such as the El Paso Carlsbad failure, the California market can avoid the gas price spikes that immediately followed that outage. Such price jumps of over $1/Mcf, at the average CA consumption rate of 6.5 Bcf/day, would save at least $6.5MM/day for every day of avoided commodity price movements due to a similar major service disruption.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to ensure continuity of public service and safe operation, and avoid life- and property-threatening incidents. As such, results of the study will be directly used by pipelines within California to enhance their reliability and therefore would generally benefit the public. Improved methods of locating, assessing, and predicting the behavior and influence on integrity of SCC colonies will reduce costs associated with maintenance and mitigation pursued by operators to ensure the serviceability of this long-lived asset. These benefits flow directly to gas consumers in the form of reduced cost of transmission service and more intelligent and cost-effective design tools. Both existing gas customers and incremental (new) customers would gain. PRCI has previously sponsored work on the technologies to reduce the likelihood of SCC formation and guidelines for hydrostatic retesting to assure the integrity of pipelines with SCC that will contribute significantly to the probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

Objectives

The proposed research will enable operators to determine where SCC exists (susceptibility assessment) and how to find it (detection). To address the susceptibility question, studies should result in an improved understanding of the role of environmental and geological parameters, coating deterioration and operating conditions on the likelihood of SCC and SCC growth rates. To minimize the cost of managing SCC,

identifying the geographical areas for maintenance activities and determining optimum frequencies for inspection and maintenance can be developed, and methods predicting where “significant” SCC, as opposed to insignificant SCC can be developed.Determination of the physical requirements for SCC crack coalescence and accelerated deterioration will also be investigated. To advance detection technology, new tools capable of identifying the properties of a pipe that change due to the presence of a colony of stress-corrosion cracks and for measuring these changes in properties will provide a first step in identifying a novel ILI technique that would not have the shortcomings of current techniques. The research will also further technologies in the use of MFL signals to detect coating adherence, and for the determination of stress as detected by a novel manipulation of MFL ILI signals. Knowledge gained from the execution of studies in the aforementioned areas will ultimately provide input for the development of a protocol for SCC direct assessment and an industry standard for relating environmental factors to SCC occurrences.

Budget

2005 : 600000
2006 : 500000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #124: Solid-State Sensors for Natural Gas Applications

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Description

Natural gas is used in alternate fuel vehicles, and it is also used in stationary fuel cells to generate electricity.

One major problem with natural gas is the methane containt can varie from 75 to 98% based on its source of origin. Natural gas can contain sulfur-based impurities that could be harmful to the alternate fuel vehicle catalytic converter catalyst or to the fuel cell protonic exchange membrame (PEM)catalyst.

We would like to propose the development of two solid-state sensors that can be used with natural gas applications.

The first sensor is a methane quality sensor, the second sensor is a hydrogen sulfide sensor.

The solid-state methane quality sensor will measure the concentration of methane in natural gas. This is important to natural gas powered vehicles, because when the engine is calibrated with natural gas that has a certain concentration,and then it is run with natural gas of different wethane concentration, the performance and the exhaust emission will suffer.

With the availability of a methane concentration sensor, the natural gas powered wehicle engine can use adaptive control to adjust to the methane concentration of the fuel in the fuel storage tank. As a result the driving performance of the vehicle and the emissions will not be affected, and degraded.

Sulfur-based compounds are known to poison the catalyst in the catalytic converter. Unlike gasoline, which goes through quality control, natural gas could contain sulfur-based compunds and does not go through the same quality control as gasoline.

We propose to develop a solid-state hydrogen sulfide detector, that can be used in natural gas powered vrhicle.

Stationary fuel cells will play a major role in distributed and backup power generation. Since natural gas infrastructure is already developed, this makes natural gas a prime candidate as a fuel for fuel cells in residential. commercial, and industrial applications.

The two proposed solid-state sensors will be important to the deployment of natural gas based stationary fuel cells.

Benefits

The innovative solid-state sensors will help accelerate the deployment of natural gas based stationary fuel cells in residential, commercial, and industrial applications.

The use of distributed stationary fuel cells will increase the electric grid reliability, by reducing the load especially during high demand.

Many of the electric power plant use coal, whose major drawback is that it contains sulfur, nitrogen, and trace of heavy metals like mercury, precursors of pollutants that could have negative effects on the environments and the health of the population.

Natural gas is a cleaner burning fuel, methane powered vehicles will be less polluting than gasoline based vehicles.

The use of natural gas in alternate fuel vehicles will reduce the US dependancy on foreign oil-imports.

Responsiveness to CEC Goals

This project concept meets the definition of "public interest":

It focuses on energy efficiency, fuel cells generate electricity with high efficiency, and zero pollution, which is good for the environment.

It focuses on the enviroment, by using less coal to produce electricity, we will reduce emissions especially heavy metals like mercury.

The project concept will seek collaborations with two california-based alternate fuel vehicules and fuel cells companies, IMPCO Technologies in Cerritos, and Quantum Fuel Systems in Irvine.

Also, a collaboration witg the Natioanal Fuel Cell Research Center at the University of California Irvine.

Objectives

With the price of oil reaching new highs, and the US having lots of natural gas, alternate fuel vehicles will be an attractive and econimical alternative to expensive gasoline.

We would like to develop the solid-state sensors using micro-electro-mechanical-systems (MEMS) and semiconductor processing technology.

Once the sensors are fabricated , and tested, we will collaborate and work with IMPCO Technologies, and Quantum Fuel Systems to test these sensors on nstural gas based vehicles.

We will work and collaborate with the National Fuel Cell Research Center at the University of California Irvine, to test the sensors performance on a natural gas fuel cell system.

Budget

2005 : 250000
2006 : 250000
Other :

Comments

Because the solid-state sensors will be based on MEMS, and semiconductor processing technologies, they will be mass produced at a very economical price.

Project Concept #125: Condition Assessment Tools for Non-Piggable Pipelines

Pipeline Research Council International, Inc. (PRCI), Potential sponsor
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Description

Although natural gas transmission and distribution piping is most heavily affected by excavation damage, corrosion is the second largest cause of identified failures for these systems. While property damages related to corrosion vary from year to year for both liquid and gas lines, since 1992, 19 fatalities, 57 injuries and nearly $218 million in costs for clean up and repair have been sustained by the industry from corrosion defects. Historically, corrosion-related failures have been attributed to an inability to effectively collect, interpret and act on findings from integrity investigations.In-line inspection (ILI) and hydrotesting are typically used to provide information about an in-service pipeline's condition. ILI tools can provide information for integrity assessments regarding wall loss and geometric deformities. They require launching and receiving facilities to be able to be utilized while the line is in service. Older pipelines may contain other obstructions to the passage of these devices such as frequent diameter changes or vintage connections. Hydrotesting provides strictly information on the pressure-containing capacity of the pipe, but in some cases, it may not be practical to take a pipeline out of service to perform a hydrotest, and disposal of hydrotest waters may be cumbersome and costly. For those pipelines that cannot be inspected with conventional ILI tools or subjected to pressure strength testing, termed non-piggable pipelines, an alternate method for gathering information about the pipeline's condition is required. This program is focused on the development of tools that will provide metal loss information for non-piggable pipelines from three different perspectives; inside the pipe, directly over the pipeline on the ground surface and indirectly along the pipeline for those shielded pipe locations.

Benefits

Reduced maintenance costs for integrity management, improved safety of pipeline operations, and validated standard industry recommended practices are the primary benefits that will result from the proposed research. When coupled with work currently underway at PRCI, program efforts will originate early acceptance of external and internal corrosion DA and novel above-ground and internal tools for non-piggable pipelines as validated and effective methods for assisting regulatory compliant integrity management assessments, thereby saving industry and the consumer substantial near-term costs to ensure the continued and safe operation of our pipeline infrastructure. This work will avoid the service outages caused by hydrostatic testing, which can greatly inconvenience wide service areas, and thus minimize these direct customer cost impacts.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to ensure continuity of public service and safe operation, and avoid life- and property-threatening incidents, and will provide operators with the requisite tools to respond to mandatory legislation surrounding inspections and integrity assessments. As such, results of the study will be directly used by pipelines within California to enhance their reliability, and therefore, would generally benefit the public. Needed tools and protocols for the safe and thorough inspection of non-piggable pipelines are essential to efforts aimed at ensuring the serviceability of this long-lived asset. These benefits flow directly to gas consumers in the form of reduced cost of transmission service and more productive and cost-effective inspection tools. Both existing gas customers and incremental (new) customers would gain. PRCI has initiated the proper strategy for developing tools to meet the specific inspection needs for non-piggable pipelines, including gap and evaluation studies to identify requirements for the most promising tools for in-line, above ground and in-the-ditch corrosion characterization, and drafting guidance, based on historical studies and validation efforts, for operators seeking to apply DA programs in their integrity management protocols. Consequently, this work will contribute significantly to the probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

Objectives

Three areas of research are targeted in the proposed program with the specific objective of providing reliable data for integrity assessments: (1) to develop an above ground metal loss inspection tool, (2) to develop an ILI metal loss tool for non-piggable pipelines, and (3) to develop an indirect metal loss inspection tool for shielded pipelines. There are numerous technologies that have the potential to meet industry's need for the development of metal loss detection tools to inspect non-piggable pipelines. To ensure that tools meeting each of the specific inspection needs are available for use by pipeline operators in their current and future assessments, direct assessment (DA) technologies for both internal and external corrosion must be thoroughly assessed and validated to provide proper guidance, novel techniques for internal inspection of currently non-piggable lines either on or off-line (e.g., alternative designs for crawler platforms and long-range ultrasonics) must be developed, and techniques for above ground and in-the-ditch corrosion detection and measurement must be enhanced.

Budget

2005 : 600000
2006 : 600000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #126: Incorporating Natural Gas Price Dynamics into Forecasting and Planning Models

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Description

Natural gas price forecasts are a fundamental input to several energy policy areas, including investment in natural gas production and delivery capacity, investment in electric capacity (particularly fossil fuel vs renewable sources), and conservation and efficiency programs for both gas and electricity. Gas price projections are typically based on more or less complicated general equilibrium models that attempt to balance economic and demographic growth, fuel availability, and technological change. While these models capture numerous interactions within the economy, they're incapable of representing the dynamic phenomena frequently seen in real markets. To a certain extent, the effect of price dynamics (or volatility) is captured in forward contract prices, but as forward markets and spot markets are subject to similar forces and trends, forward prices can also show significant volatility over the time scales that are typical of planning horizons. Since decisions, once made, can be difficult to modify or reverse, considerable costs may be incurred by underestimating the likelihood of "abnormal" market events. Our proposal will address two aspects of this problem: (1) from a review of the data, what are the dynamics of natural gas markets, and how can they be represented in a sufficiently straightforward way so as to be incorporated in planning models, and (2) in the context of energy efficiency programs, how sensitive are policy outcomes to price forecast scenarios, what are the costs of poor predictions, and is it possible to minimize planning risk.

Benefits

The events in California in 2000-2001 provide a graphic illustration of the potential ill effects of unanticipated market dynamics and instability. Even in normal times, the financial impacts of accounting for dynamic market behavior (or hedging against it) can be significant. Bolinger et al(1) compared natural gas forward prices to EIA projections and showed that forward prices are higher by $0.4-$0.8/MMBtu. This can be interpreted as the cost or value of hedging against gas price volatility. Coughlin & Van Buskirk(2) looked at the additional cost incurred when electricity capacity investments occur in a boom-bust dynamic, rather than through smooth increments as is typically assumed in forecast models. The dynamic cycle can add a premium on the order of $1-$3/Watt to the investment cost.

In the case of possible wide introduction of condensing residential furnaces, there are significant potential economic benefits to California under scenarios using higher forecast energy prices. For example(3), EMF and NPC scenarios yield above $4.5 billion nation wide compared to no economic benefits if the current AEO 2003 forecast is used.

Responsiveness to CEC Goals

This project satisfies criterion (1) because it attempts to address open scientific problems related to the dynamic behavior of prices and markets, and how this behavior should be dealt with in forecasting models. It satisfies criterion (2) because improvements in the accuracy and robustness of energy planning and management provide economic and social benefits to all Californians. It meets criterion (3), because our approach will address a broad set of stakeholder perspectives, not just the perspective of utilities, and because we will be trying to apply relatively new mathematical methods which may not be sufficiently well-known or well-tested to be in wide use currently in the industry.

Objectives

The goal is to develop modeling and data analysis tools that are mathematically adequate to:

-represent the dynamic behavior of natural gas prices at different time scales

-improve the characterization of large scale (world market) trends that may move the overall market price, for example, including developments in China and India since 1995

-investigate the interaction of trends that occur over different time scales (for example, long time scale investment patterns; medium time scale consumer market transformation; short time scale price volatility)

-develop criteria that permit a measure of the "robustness" of planning goals under different scenarios to be maximized (for example, a risk-minimization, as opposed to cost-minimization, approach)

-understand how the risk inherent in uncertain and dynamic market behavior is distributed over different participants or stakeholders

-convert the mathematical models to conceptual and practical tools, being sure to incorporate the perspectives of diverse stakeholders

Budget

2005 : 100000
2006 : 100000
Other : 100000

Comments

Project Concept #127: Develpment of Simulation Models for Gas-fired Components and Combined Heating, Cooling, and Power Ge

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Description

A key component of any natural gas research effort should be the development of enhanced simulation capabilities for gas-fired equipment and combined usage strategies. Over the years considerable effort has been devoted to creating reliable, validated computer programs for simulating buildings and HVAC equipment. Within this effort gas-fired equipment and combined heating, cooling and power strategies have been relatively neglected.

This program would support the development of new, more capable models of gas turbines, engine-driven chillers, gas fired, steam and hot water driven absorption chillers, desiccant cooling, and fuel cells. The models should be based on first principles (of thermodynamics, heat transfer and fluid mechanics) and should be delivered in an equation-based format lending itself to use in a widely available solver such as SPARK, TRNSYS or EES.

This program should also support the development of system-level simulation models that would permit the assessment of on-site power generation in conjunction with waste heat usage for space heating, process heating and/or

cooling with absorption chillers. Lastly, the program should support the use of these models in conjunction with existing building simulation programs to permit the modeling and assessment of the combined building/plant system.

Producing models is only one step on the path to having useful simulation capability. The models, both individually and in combination, need to be validated by comparison to measurements made on real-world systems. The models will need full engineering documentation and need to be packaged

in a form that will allow them to be widely used.

Benefits

The public would benefit from this proposed field of research for the following reasons.

1) The capability to simulate proposed systems will lead to correct choices being made in terms of reduced overall energy usage and/or reduced peak demand. Impartial assessment and enlightened decision making is only possible

when choices can be compared in an open, reproducible and reliable manner.

2) The ability to correctly simulate gas-fired systems will encourage their use and lead to increased system diversity in California. Increased diversity of power producing equipment and air-conditioning equipment can only enhance

future overall energy availability and reliability in the state. Since the energy future is uncertain, it is to the public benefit to encourage diversity rather than depend too much on a single energy source, generating type, or

air-conditioning method.

3) Demand limiting strategies have the potential to alleviate summer power shortfalls. Simulation of gas-fired equipment at sub-hour timesteps in combination with site grid connected power demands is essential for customers and utilities to plan their use of this strategy.

Responsiveness to CEC Goals

The development of enhanced simulation capabilities for gas-fired components and systems will be in the public interest for the following reasons.

1) It will permit the impartial assessment of power generation and air conditioning systems and strategies. Without the capability for simulation, choices will be largely guesswork and wrong choices may be made.
2) Robust, validated simulation capability is needed in order to "optimize energy conservation and resource efficiency". Optimization implies simulation. If there is no means of simulating

system choices, there will be no method for optimizing energy conservation or resource efficiency.

3) Enhanced simulation capability will encourage the development of distributed generation. If utilities and customers can simulate proposed on-site power projects and demonstrate the benefits they will be more likely to go ahead with such projects.

The US DOE currently supports the development of energy related simulation capabilities. US DOE would be a potential source of matching funds for this type of project

Objectives

1) Produce robust equation-based models of gas-fired equipment.

2) Describe the models in full detail in accompanying engineering documentaion

3) Develop example cases and inputs.

4) Combine the component models into system level models permitting the assesment of combined heating, cooling, and power generation schemes.

5) Validate the component and system models by comparing with measurements made on real-world components and systems.

6) Demonstrate the usage of the combined models in combination with an existing building energy simulation program.

Budget

2005 : 800000
2006 : 800000
Other : 800,000
2007

Comments

Note that this project concept is proposing a simulation capability more advanced than that available in existing whole building energy analysis programs such as Doe-2, Blast, or EnergyPlus. The models would be first-principle, equation-based (non algorit

Project Concept #128: Gas Transmission Measurement Equipment Operating Range Expansion

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Description

Changing gas transmission flow patterns and increased volumes can lead to a mismatch in the capacity of existing meter stations and the current measurement requirements. The proposed project will determine the acceptable operating envelope of undersized and oversized gas meter station equipment . For instance, it may be possible to increase the throughput limit for existing orifice flow meter stations by relaxing restrictions on orifice plate beta ratio size and/or differential pressure limits (assuming that supporting test data were available). The alternative would be to replace the existing meter tubes with higher-capacity (i.e., larger diameter) units – an option that could cost $10,000 to $50,000 more per meter station, depending on meter station capacity.

With an increase in gas delivery system capacity likely to be needed in the relatively near future in California, the existing infrastructure should be assessed to determine its ultimate throughput limit. It may be possible to substantially expand current meter station operating ranges through relatively minor system modifications, thus minimizing capital expenditures.The proposed research project would entail an assessment of current meter station performance for operating conditions beyond current design limits would include the following:

·Investigation of the gas velocity restrictions placed on existing meter systems and the potential for expanding the existing operating limits.

·Quantification of the influence of velocity-induced noise on meter performance.

- oControl valves and other flow/pressure control equipment.
- oMeter station piping configuration.

Benefits

Extended operating envelope and enhanced capacity for natural gas delivery system meter stations will defer capital expenditures that would otherwise be required to prepare the CA gas transmission system, as well as large volume gas customers, to accommodate significant swings in gas flows and overall increases in gas demand. If the installation of additional meters can be avoided through expanding the operating range of existing meter stations, those savings have direct benefit for all gas customers, as gas rates are based on the in-service capital base of the CA utilities. This would also have a flow-through benefit effect on CA consumers if pipelines serving CA employed the same results and, thus, avoided incremental meter installations. Gas transmission costs for CA delivery would be reduced accordingly.

Responsiveness to CEC Goals

The proposed project is consistent with CPUC criteria as follows. It will benefit the public though minimization of gas company capital expenditures associated with system expansion; thus, reducing the gas utility rate base, which is a benefit to all gas consumers. The probability of success is high, as conventional technologies will be evaluated by experienced researchers using state-of-the-art, highly-calibrated gas measurement test facilities. For implementation of results, it may be possible, with relatively minor modifications, to expand meter station operating envelopes. The project will, thus, help to ensure maximum gas deliverability while maintaining accurate measurement of gas volumes. Maintaining reliable gas service is an objective of the State Energy policy. Finally, this project offers the potential to collaborate with, and obtain co-funding from Pipeline Research Council International, the leading privately-funded pipeline R&D organization. This program would otherwise not be funded by PRCI alone due to significant budget constraints.

Objectives

Define the maximum acceptable range of operation for various gas meter technologies when under/oversized. Quantify the risk to measurement accuracy, precision, and bias associated with operating meter stations outside typical manufacturer-recommended ranges.

Budget

2005 : 250000
2006 : 250000
Other : 250000

Comments

There is the potential to obtain co-funding from PRCI, the U.S. Bureau of Land Management, the U.S. Minerals Management Service, the U.S. Department of Energy, the American Gas Association, and/or, the American Petroleum Institute.PRCI is a subscription-b

Project Concept #129: Accommodating Liquefied Natural Gas (LNG)

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Description

The U.S. Department of Energy estimates that imported LNG will meet 17% of the U.S. demand for natural gas within 20 years. Significant investment in port and LNG regasification facilities is required before imported LNG can be introduced in significant quantities into the U.S. transmission pipeline network. Questions have been raised concerning gas quality (i.e. heating value) variations and the interchangeability of regasified LNG for domestically produced natural gas. Because LNG is typically produced in geographical areas without local markets for liquefied petroleum gases (ethane, propane, butane), these components of natural gas are not extracted from produced gas before liquefaction. As a result, regasified LNG can have a significantly higher heating value and molecular weight, and significantly lower values of speed of sound, than domestic natural gas. Values of standard heating value may vary from low (e.g., 1050 Btu/scf) to medium (e.g., 1110 Btu/scf) to high (e.g., 1170 Btu/scf) depending on the source.Little attention has been paid to potential effects of regasified LNG on the accuracy of orifice, gas turbine and multipath gas ultrasonic flow meters, and gas chromatographs used for custody transfer measurement of natural gas. The proposed project will investigate the effect of LNG on the exising natural gas measurement infrastructure.

Benefits

This project will answer questions concerning the potential impact of regasified LNG on the accuracy of custody transfer flow rate measurements. In almost all instances, net gas receipt and delivery imbalances are placed into a “lost and unaccounted for gas” (LAUF) account. (This account name may vary slightly in California). These volumes – valued at the current commodity cost of gas – are flowed through to customer bills, as an element of the cost of service. Any reductions in these LAUF totals will directly reduce consumer charges.

Flow rate bias errors as low as 0.1% to 0.2% can have a significant influence on LAUF gas. For example, a 0.2% difference between the projected amount of LNG that will be consumed in California (17% of the 2.2 trillion cubic feet of gas consumed annually) and the amount of gas measured, due to flow rate bias errors, could account for $5,000,000 in overpayment by ratepayers (based upon an annual average pipeline delivered California cost of $6.50/Mcf). Actual errors will be distributed throughout the gas transmission and distribution infrastructure, and could either offset or compound the 0.2% bias discussed in the example. However, the example provides a reasonable estimate of the financial risk associated with inaccurate measurement of LNG flow rate.

Responsiveness to CEC Goals

If any measurement biases associated with LNG are discovered, this project will quantify their effect, thus, reducing gas company operating costs associated with LAUF gas volumes, providing a direct benefit to the general, gas-consuming public through reduced LAUF expenses in rates. These results will also assist in measurement dispute resolution, which is a significant cost and uncertainty burden that is borne by consumers, their local utilities and, in some cases, the State of California.

Objectives

The objective of this project is to critically compare the measurement of medium- and high-Btu regasified LNG to a comparable measurement of natural gas blends acquired from a domestic utility.

Budget

2005 : 300000
2006 :
Other :

Comments

There is the potential to obtain co-funding from PRCI, the U.S. Bureau of Land Management, the U.S. Minerals Management Service, the U.S. Department of Energy, the American Gas Association, and/or, the American Petroleum Institute.PRCI is a subscription-b

Project Concept #130: Accommodating Varying Gas Chemistries from Non-Traditional Gas Supplies

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Description

In the coming years, the increase in the demand for natural gas may lead to wide variations in the quality of the gas supply available to California, as this incremental demand is met by LNG imports, by supplies from depleted reservoirs, and by renewable resources, such as biogas. Variations in gas composition can cause increases in the amount of pollutants emitted by gas-fired equipment, such as power generation turbines, reciprocating engines, and large-scale industrial burners and process units. For example, a 0.5% increase of hexanes and heavier components in the fuel gas supply effectively doubles NOx emissions of most large industrial gas turbines. Consequently, most gas turbine manufacturers will not guarantee exhaust emissions outside a very limited range of fuel gas compositions. In extreme cases, contaminants in the gas stream can cause damage to this equipment, with associated unit downtime and repair costs being incurred. Variations in gas quality associated with contaminants, such as water vapor and hydrocarbon liquids in the gas stream, can also lead to pipeline corrosion concerns and thus to increased operating costs and possibly increased remediation costs, all of which are passed through to the gas consumer. Gas transportation systems require real-time, accurate and reliable methods to detect and react to changes in gas quality, reducing the likelihood of off-specification natural gas reaching large industrial consumers, as well as residential consumers. The development of improved methods to measure and predict gas properties requires basic research to understand the fundamental physical and chemical behavior of gas mixtures.

Benefits

This project will provide natural gas transmission and distribution system operators and large industrial consumers with tools to provide accurate, real-time monitoring of gas quality and gas properties, enabling their ability to react quickly to changes in gas properties, avoiding increased emissions, reducing operating costs and providing a safer infrastructure.

Responsiveness to CEC Goals

The project will benefit the public through reduced combustion emissions, reduced operating costs, and improved safety. In addition, the stated objective in the State Energy Policy is to increase the production of renewable resources, including biogas, which also contains varying energy content (i.e. heating value). If renewable gas supplies become a significant element of overall California gas supplies, it must also be determined how these gas properties change on a very short-term basis, as a great deal of the electricity-generating capacity (modern gas turbines and new reciprocating engines) is designed to assume a relatively constant fuel chemistry. If there are significant changes to the gas supply, this equipment may suffer performance degradation or exceed permitted emissions limits strictly due to these changing fuel gas blends.

Objectives

This project will develop and improve methods and equations for determining gas properties, such as hydrocarbon dew point and the presence of contaminants, such as water. In addition, if the heating values of LNG and renewables blends can be determined in near real-time, this will facilitate the operation of power generation equipment (gas turbines and reciprocating engines) that must adhere to very strict California emissions standards. It is possible that feed-forward controls that accommodate changing gas chemistries can be developed if the chemistries themselves can be determined via real-time gas measurement capabilities.

Budget

2005 : 1000000

2006 : 1000000
Other : 1000000

Comments

There is the potential to obtain co-funding from PRCI, the U.S. Bureau of Land Management, the U.S. Minerals Management Service, the U.S. Department of Energy, the American Gas Association, and/or, the American Petroleum Institute.PRCI is a subscription-b

Project Concept #131: Reduction of Lost and Unaccounted for Gas Volumes

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Description

The purpose of this project will be to develop technologies and methods to reduce lost and unaccounted for (LAUF) gas volumes. This will minimize pass-through costs (to gas consumers) associated with inaccurate measurement and gas leaks from the gas delivery system. Better LAUF detection methods should also help identify and eliminate system leaks that would otherwise have an adverse effect on the environment.Elements of the proposed research project include the following:· Development of a measurement uncertainty checklist (i.e., an uncertainty calculator) that could be used to audit meter stations.· Development of guidelines for system balance procedure.· Development of new, more cost-effective in-situ meter proving methods to assess meter accuracy at field meter stations.· Definition of industry-acceptable check metering performance specifications, systems, and procedures to help identify potential metering problems at custody transfer points that could adversely affect system balance.· Development of real-time meter diagnostics to better infer meter performance and accuracy in a timelier manner.· Development of guidelines for meter calibration/proving frequency intervals to help optimize meter calibration intervals and minimize facility maintenance costs.· Development of guidelines for meter station inspection frequencies to minimize facility maintenance costs.· Assessment of the effects of flow pulsations/unsteady flow on meter accuracy.The technologies and methods developed by this project would be utilized by all pipelines operating in California, as well as by pipelines bringing gas supplies to the California border.

Benefits

In almost all instances, the net gas receipt and delivery imbalances are placed into a “lost and unaccounted for gas” account. (This account name may vary company-by-company). These volumes – valued at the current commodity cost of gas – are flowed through to customer bills, as an element of the cost of service. Any reductions in these LAUF totals will directly reduce consumer charges. Nationwide, the average system measurement imbalance due to LAUF is, at best, on the order of 0.25 to 0.5% of total volume. In many instances, the imbalance is significantly greater. Total annual gas consumption in California is on the order of 2.2 trillion standard cubic feet of gas. If the nominal system imbalance due to LAUF for California gas delivery systems could be reduced by just 0.2% (of total volume consumed), the annual savings (based on gas costing nominally $6.50 per Mcf) would be over $28 million.Identification of system leaks due to improved measurement accuracy will also help minimize the adverse environmental impact from natural gas emissions to the environment. These impacts have not been quantified, but could conceivably cost California gas companies hundreds of thousands of dollars, or more, annually. In addition, the climate change potential of these methane emissions is not calculated here.

Responsiveness to CEC Goals

If successful this project will reduce gas company operating costs associated with LAUF gas volumes and system leaks, thus, providing a direct benefit to the general, gas-consuming public through reduced LAUF expenses in rates. In addition, the results will point to locations where physical loss of gas is occurring, which will provide environmental benefits as those locations are remediated. Both of these impacts will apply to in-state and out-of-state delivering pipelines. Finally, these results will assist in measurement dispute resolution, which is a significant cost and uncertainty burden that is borne by customers, the utilities, and, in some cases, the State of California.

Objectives

Improve the accuracy of gas measurement and reduce lost gas volumes through the development of tools that identify and quantify the effect of measurement inaccuracy at the system level. Project results would identify improved practices, methods, and operating guidelines so that the existing measurement

infrastructure could be operated with greater overall accuracy. This project does not plan to develop new equipment.

Budget

2005 : 500000
2006 : 500000
Other :

Comments

There is the potential to obtain co-funding from PRCI, the U.S. Bureau of Land Management, the U.S. Minerals Management Service, the U.S. Department of Energy, the American Gas Association, and/or, the American Petroleum Institute.PRCI is a subscription-b

Project Concept #132: Effective Fuel Process Control for High Efficiency Natural Gas Fuel Cells

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Description

A natural gas fuel cell system is one of the most efficient fossil-fuel energy conversion systems available. It is also one of the cleanest electric-generating technology options that exist today for producing high-quality, reliable electric energy. Natural gas fuel cell system is composed of three inter-connected sections: a fuel processor (or a reformer), a fuel cell stack (e.g., solid oxide fuel cells), and a DC-to-AC power converter. High efficiency natural gas fuel processor is key to high efficiency performance of the entire fuel cell system. Two dominant methods of converting natural gas to hydrogen include steam reforming and partial oxidation. Steam reforming is well suited for steady-state (power plant) operation, but it suffers from poor transient operation characteristics. Partial oxidation process, in which hydrogen is generated in a catalytic partial oxidation reactor where natural gas is combined with oxygen (in air) over a solid catalyst bed, offers advantages for cost-effective residential and business applications, such as compactness, rapid startup, and responsiveness to load changes. However, current partial oxidation process technology delivers low conversion efficiency. In order to significantly improve the efficiency of natural gas fuel cells, effective control of the dynamic behavior associated with the flow and pressure in the fuel processor and the temperature of the catalyst bed is critical. Lawrence Berkeley National Laboratory proposes to develop an effective fuel process control technology to improve the efficiency of natural gas fuel cells, especially for residential and business customers in California. The objectives of the proposed research include increasing natural gas-to-hydrogen conversion and cell stack hydrogen utilization, in the mean time protecting the fuel processor from overheating and the stack from hydrogen starvation. A control-oriented model will be developed in the first year, followed by optimization and implementation of the control mechanisms (actuators/sensors) into a prototype natural gas fuel cell system for high efficiency demonstration. Natural gas fuel cell manufactures will be involved in the proposed research, and co-founding will be offered by the manufactures.

Benefits

Natural gas fuel cell can be a cost-effective energy technology alternative, which converts natural gas into electricity to provide a quiet, clean, and highly efficient on-site electric generating system and thermal energy source that can reduce facility energy service costs. The cost savings come from fuel switching: by reducing electricity consumption and increasing natural gas consumption, operational energy costs can be reduced 25 to 40% over conventional energy service. In particular for residential (and business) customers in California, fueling fuel cell systems using natural gas is preferred because of the State's wide availability and extensive natural gas distribution network.

Responsiveness to CEC Goals

Regarding public interest:

- The proposed technology will benefit California citizens by offering high efficiency, low cost residential energy generators. The natural gas fuel cell utilizes an alternative cogeneration technology for improving natural gas utilization and efficiency. It is an environmentally friendly fossil-fueled energy generator with cleaner emissions than the ambient air in many cities. Natural gas fuel cell can serve effectively as an on-site energy supply to meet needs for base-load electricity, as well as heat and hot water.
- The proposed technology, with the focus on innovative fuel process control of natural gas fuel cells, has not been adequately addressed by competitive or regulated entities.

Regarding proposal criteria:

- Focus on energy efficiency, renewable technologies, conservation and environmental issues:
- The proposed technology directly addresses energy efficiency.

- Support State Energy policy:
- The proposed technology has clear energy, environmental, as well as economic benefits.
- Offer a reasonable probability of providing benefits to the general public:
- The proposed technology will enable cost savings for general public's energy use.
- Consider opportunities for collaboration and co-funding opportunities with other entities:
- Co-funding will be available from fuel cell manufacturers.

Objectives

The objectives of the proposed research - high efficiency natural gas fuel cells - include increasing natural gas-to-hydrogen conversion and cell stack hydrogen utilization, in the mean time protecting the fuel processor from overheating and the stack from hydrogen starvation. The outcome of the proposed R&D will be deployable, efficient, and cost-effective fuel cell system technology that uses natural gas as the fuel.

Budget

2005 : 280000
2006 : 320000
Other : 300000

Comments

Project Concept #133: Natural Gas Impurities – Impact on Appliances and Equipment

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Description

Research has shown that variable natural gas quality impacts the performance and reliability of appliances and commercial and industrial equipment. Increased demand for natural gas in California will be satisfied by a diversity of sources, each of which possess distinct compositional characteristics (interchangeability) and quality (level of impurities). Past studies in California on the impact of natural gas quality impacts on appliances and equipment have only focused on a few select utility companies. There are two main goals of this study: (1) on a statewide level, to assess the impact of natural gas composition (including impurities) on the performance of appliances and equipment, and (2), assess the impact on natural gas composition (including impurities) by the introduction of LNG.

Benefits

Economic and social benefits are derived from this project. Economically, consumers would benefit from increased savings over the lifetime of the appliance and/or equipment by increasing the efficiency by improved natural gas quality. In addition, consumers will benefit from prolonged appliance and equipment life by improved natural gas quality. An incremental improvement in appliance performance of natural gas, multiplied by the number of users of natural gas in California, would have a large impact on the physical savings of natural gas. On a larger scale, all consumers of natural gas would benefit by the increased supply of natural gas available in the pipeline.

Indoor air-quality will be improved by reducing pollutants such as particulates and CO that occur when natural gas combustion is incomplete. On a larger scale, outdoor pollutants would be reduced by improved natural gas quality (reducing amount of impurities) such as particulates and NOX emissions, by use by industrial and electric generation consumers of natural gas.

Responsiveness to CEC Goals

This project directly benefits the citizens of California by increased energy savings from better performing appliances and equipment and reduced emitted air pollutants. The practice of importing natural gas from different sources (including LNG) is relatively new and has not been adequately addressed by competitive or regulated entities. Therefore, the problem of consistent natural gas quality and an evaluation of impurities have yet to be analyzed at the statewide level.

Objectives

The most important objective of this study is to develop recommendations for Gas Utilities on the "right" composition of natural gas to provide the best performance of appliances and equipment for consumers that is both technologically feasible and economically justified. This will be accomplished in the following ways:

·An assessment of different types of natural gas interchangeability indices and quality criteria will be performed in order to determine optimal regional specifications, in order to ensure the best performance of different appliances and equipment.

·An assessment of economic and environmental benefits. This will include testing different types of appliances with different natural gas compositions and/or analysis of existing data.

·An assessment of the magnitude of benefits to the Utility. If modifications to natural gas composition are determined to be beneficial, are the benefits large enough for Utilities to adopt policies to significantly change gas mix and monitoring?

·An assessment of the possible barriers to implementation of any possible recommendations.

Budget

2005 : 50000
2006 : 100000
Other : 100000

Comments

The proposal will have an analytical and experimental component. Although the best results will be achieved by combining both components, the analytical approach will provide sufficient and conclusive results.

Note that the proposed budget refers to t

Project Concept #134: Pipeline Right-of-Way (ROW) Environmental Management

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Description

Permitting for new pipeline construction is often delayed by local, State and Federal agencies charged with assuring the protection and safety of the environment and right-of-way through which the pipeline passes. Concerns for the potential fragmentation of critical habitats and destruction of vegetation can lead to re-routing and/or higher design and construction costs to accommodate governing agencies. Once permitted and installed, agencies may become concerned with requests for adding more pipelines to the same ROW, as this poses a potential additional environmental stress on the particular ROW. In addition, validating the integrity of the newly installed pipe requires hydrotesting prior to start-up and at periodic intervals over the life of the segment. While costs for the disposal of waters used in initial hydrotesting can be as low as $1.50 per foot, when future hydrotesting for mandated integrity assessments is performed, water disposal costs can range from $30,000 to $250,000, depending on the contaminants involved, for a typical 15 mile segment of pipeline.

To assure governing agencies of the an acceptable environmental footprint of new construction and of subsequent integrity assessments, guidelines are needed to minimize these impacts on natural habitats and vegetation, and to assure the safe disposal of hydrotest waters. The proposed program will investigate integrated vegetation management strategies, methods for handling habitat fragmentation, environmental effects of multiple pipelines in the same ROW (cumulative effects), and the disposal of hydrotest waters.

Benefits

Results of the proposed research will produce improved solutions for communities, agencies and pipelines, will expedite project approvals, will improve the ability of all parties to accommodate sensitive environments, thereby assuring safety of the environment and potentially reducing costs of construction and permitting delays. Both construction cost savings and improved system capacity and flexibility due to timely project completion directly serve the interests of California gas consumers.

Responsiveness to CEC Goals

The proposed program would enable pipeline operators to provide adequate assurance of the environmental impact of pipelines that traverse sensitive areas. Previous work in this area has examined revegetation of wetlands, habitat fragmentation, the development of integrated revegetation management guidelines, and reasonable standards for hydrotest water discharges. This background will contribute significantly to the probability of success of this program, reduces the funding requirements for the CEC, and provides an opportunity for CEC to collaborate with an established applied research program.

This work falls squarely under the environmental protection CPUC criteria, and cost savings provided by improved mitigation techniques will flow through to California consumers via reduced utility operating expense. Expedited project approvals for system expansions will support the State Energy Policy objective of providing reliable gas and electric service (as electric loads are a dominant gas consumer).

Objectives

The primary objectives of the proposed research program include the development of practices for ROW maintenance and handling of hydrotest waters. The studies will focus on determining the environmental impact of pipeline construction to provide guidance for the development of recommended practices for integrated vegetation management and the handling of habit fragmentation. Environmental effects related to the addition of multiple pipelines to a single ROW and the disposal of hydrotest waters will also be studied. Ultimately, results of the research will be used to standardize design methodologies and enable simplified information exchange, and to facilitate permitting by minimizing conflicts with local, State and Federal agencies to prevent significant delays.

Budget

2005 : 400000
2006 : 300000
Other :

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #135: Impact of Gas Composition on Reciprocating Engine Performance and Emissions

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Description

The chemical composition of natural gas in California is expected to become more variable as traditional supplies are augmented by LNG imports and by additional renewable biogas sources that are encouraged in the State Energy Plan. Reciprocating engines operating in California normally have very restrictive emissions limits. These units can be very sensitive to the fuel gas chemical composition. A comprehensive evaluation of the effects of varying fuel gas composition on engines used in distributed generation and in pipeline gas compression is needed to determine the nature of hardware and control modifications this equipment may require to remain in compliance, and to maintain peak operating performance.

A facility for controlling and varying fuel gas composition, and for precisely determining the effects on engine performance and emissions is required to properly conduct such studies. The Engines & Energy Conversion Laboratory at Colorado State University is the logical location to install such gas blending capability, since an array of the engines typically found in distributed generation applications and the pipeline compressor engines used throughout California are already installed there. This is the only independent location known with such established large engine infrastructure. In addition CSU has extensive precision emissions measurement systems in-place, and a complete array of engine performance monitoring equipment.

Benefits

Advanced reciprocating, internal combustion engines are a cost-effective, reliable and environmentally sound method for producing distributed generation capacity, and are likely to remain prominent for the next 20 years. A comprehensive understanding of bio-gas and pipeline gas is necessary to support the ARICE goals 1) a cost of electricity that is competitive with grid-supplied electrical energy, 2) low environmental impact, 3) high reliability and 4) market connection. Pipeline compressor engine performance and emissions compliance is fundamental to maintaining adequate gas service to all customer classes in California. Knowledge of the effects of these varying fuel gases on compressor engines will reduce the chance of outages due to extended maintenance, unit failures or emissions excursions. During peak demand periods, the cost of compressor outages and reduced throughput can be extremely high as gas deliveries may be curtailed.

Responsiveness to CEC Goals

Action III of the State Energy Action Plan is “Ensure Reliable, Affordable Electricity Generation”, and fuel composition is critical to this requirement to the extent it may affect mechanical outages and air emissions compliance. Action V, “Promote Customer and Utility Owned Distributed Generation” includes a list of seven (7) criteria. This project concept meets at least two (2) of these criteria: V.1, “Promote clean, small generation resources located at load centers” and V.4, “Develop standards so that renewable distributed generation may participate in the Renewable Portfolio Standard program”. In addition, the penetration and wide use of renewable gaseous fuels will be enhanced if this equipment can be made to routinely tolerate these fuels, thus supporting State renewable portfolio objectives.

As the pipeline industry has an expressed interest in this issue as it involves compressor engines, this project also affords CEC an opportunity to collaborate with industry pipeline R&D programs (see additional comments below), and obtain incremental cofunding. It is not likely that the PRCI R&D program will support this work alone in 2005, due to significant budget pressures.

Objectives

Documentation of the effects of varying fuel gas composition on engine performance and emissions. This information can be used to identify necessary modifications to existing equipment enabling it to

remain in-service and in-compliance, or to ensure that fuel gas supplies comply with a specified range of quality. In addition to overall efficiency and output, gas composition may affect required maintenance intervals and component lives – including sensors used for control and monitoring.

Budget

2005 : 1000000
2006 : 500000
Other : 800000

Comments

PRCI is a subscription-based R&D consortium of 34 leading oil and gas pipeline companies from around the world. For over 50 years, PRCI has developed technologies used widely in pipeline design, construction, inspection, testing, operations and maintenan

Project Concept #136: Solar Thermal Technology

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Description

CAL SEIA's Solar Thermal Committee proposes that an examination of the technical and commercial natural gas savings potential for small scale solar thermal technologies for water and space heating applications be conducted. Based on the outcome of the study, recommendations for developing state policies and programs which would accelerate the deployment of those applications found to be effective in the area of natural gas savings would be made.

Benefits

Responsiveness to CEC Goals

Focus on energy efficiency, renewable technologies, conservation and environmental issues,

- Solar thermal technologies which reduce the consumption of natural gas are indistinguishable, from both the end-user and utility perspectives, from energy conservation

- Each solar water heater reduces the consumption of approximately 125 therms per year, cutting NOx and CO2 emissions by 50%. Millions of natural gas water heaters are in use today, and at least 150,000 new heaters are added each year.

Support State Energy policy, see California Energy Action Plan for information on related policy objectives

- The policy objective of reduced consumption of natural gas through various means is a recurring theme throught the plan. In addition, the plan emphasizes the development and deployment of renewable technologies in order to broaden California's portfolio of energy resources.

Offer a reasonable probability of providing benefits to the general public, and

- The public has demonstrated that it is willing to purchase solar photovotaic systems in large quantities through the existing CEC Rebate Program despite the fact the technology produces approximately 1/4 the energy at at least 4 times the cost as compared with solar thermal technologies (thermal equivalent). The public does so because it believes that more solar should be used. An increasingly large percentage of electricity is generated in California from natural gas - small scale solar thermal saves that resource

Objectives

1) Identification of specific small scale solar thermal technologies, both existing and under development, which reduce the consumption of natural gas.

2) Quantification of the natural gas consumption reduction capabilities of these technologies.

3) Quantification of the financial aspects of ownership of these technologies, in both new and retrofit applications.

4) Identification of technical and institutional barriers to the increased deployment of these technologies.

Budget

2005 : 100000
2006 : 100000
Other :

Comments

This proposal is introduced in the hope that there can be a renewed utilization of solar thermal technologies in California. In Hawaii, over 3,500 systems are installed each year. Solar thermal has had a reputation since the 1980s which has followed it

Project Concept #137: NATURAL GAS FLUIDIZED CATALYTIC NANOPARTICLE REACTOR/THERMOELECTRIC SYSTEM FOR LOW ENVIRONMENTAL IMP

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Description

There is a growing demand for small-scale, portable power production applications in a wide variety of products and industries. The use of distributed power reduces the demand for peak energy production, reduces the losses in the pipelines, provides a balance between power demand and production capacity, and provides flexibility in the use of the power. The application of portable power production ranges from miniaturized mechanical devices to consumer products. Currently most of the power generation at the small scale is achieved by the use of batteries which have low energy density and thus are bulky and heavy. Their disposal is also becoming a severe environmental concern. Combustion of hydrocarbon fuels offers high energy densities, making it better-suited for portable power applications. However, traditional combustion suffers from pollutant production. These pollutant production concerns can be addressed by utilizing a high efficiency catalytic combustor system, which by catalytically reacting natural gas with air can operate at reduced temperatures and thereby reduce the formation of pollutants. By combining such a catalytic reactor with a thermoelectric generator, a high-efficiency, low-emissions portable power system can be developed. The catalytic nano-particle fluidized bed combustor proposed here would increase the efficiency of conversion because nano-particles greatly increase the specific surface area of the combustor, and because their fluidization enhances the heat and mass transfer within the reactor. The low temperatures of the catalytic combustor helps the integration of novel thermoelectrics based on nanowires that can achieve high conversion efficiencies from heat to electrical power. This is the foundation of the proposed research program, which has as objective the development of a catalytic nano-particle fluidized bed natural gas combustor/thermoelectric system that will provide efficient and environmentally clean energy conversion. Such a high-efficiency distributed power generator will help conserve natural gas reserves while reducing emissions from its energy conversion.

Benefits

Catalytic combustion can reduce NOx production to levels well below those regulated by EPA, actually to almost undetectable levels. The catalyst also promotes the preferential oxidation of other pollutants such as CO and intermediate hydrocarbons thus reducing the environmental impact of combusting natural gas for power generation. Nanoparticles offer a unique surface morphology for enhancing catalytic reactions, and therefore the efficiency gains from using these particles have great potential. Thermoelectric solid-state power generators have advantage over other heat engines because they contain no moving parts. Also the proposed thermoelectric generators operate at low temperatures, making them well-suited for portable power generation. Furthermore, because these novel thermoelectrics are fabricated from semi-conductor materials and using semi-conductor manufacturing techniques, their development could benefit the California economy in these industries.

Responsiveness to CEC Goals

Distributed power enhances conservation of natural gas usage in power plants by reducing transmission losses and by reducing the need for peak production capacity. The proposed catalytic reactor/thermoelectric system also helps natural gas conservation because of its high efficiency of conversion, while maintaining a low emissions profile. There is a growing demand for small-scale, portable power production applications in a wide variety of products and industries, from miniaturized mechanical and electromechanical devices such as minirovers, minirobots and miniairplanes, to common consumer products such as laptops, mobile phones, and portable power tools. Furthermore, the proposed research is based upon cutting-edge nanoengineering technology, the advancement of which would be a benefit to the economy of California.

Objectives

In order to achieve the development of the nano-particle fluidized bed combustor/thermoelectric system, a research program is proposed to design, test and validate the system. The specific objectives are:

1. Design a swirl-type fluidized bed reactor for optimal catalytic combustion of fuel lean CH4-air mixtures.

2. Verify the proposed design through fluid, particle tracking, and FEM modeling of the interior of the reaction chamber.

3. Fabricate an intermediate-scale reactor and to conduct preliminary testing with inert and catalytic particle suspension.

4. Conduct testing with catalytic nano-particles (such as Platinum nano-particles), and CH4-air mixtures.

5. Integrate the combustor with thermoelectric devices to generate power on the small scale.

Finite-element models and nano-particle tracking and interaction models have been developed at the University of California at Berkeley, and this program will leverage those existing models to help guide the design of the swirl –type fluidized bed combustor. Research is ongoing at the University into the generation of catalytically active nano-particles, and a variety of diagnostic techniques for nano-scale systems. In addition, novel nanowire thermoelectric devices have been designed and proven through research conducted at the University.

Budget

2005 : 300000
2006 : 300000
Other :

Comments

Project Concept #138: Efficiency Improvement in Gas-Fired Boilers, Furnaces, and Heaters by an Improved Combustion Control

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Description

Efficiency improvement of gas-fired boilers, furnaces and heaters is the single largest and immediately addressable opportunity for stationary source energy savings in California. Efficient operation requires precise control of excess combustion air to the point of incipient CO excursions. Current combustion devices generally operate inefficiently because there is no reliable, affordable method to detect CO in combustion gases and thereby enable excess air control. The team of TIAX and Coen propose to develop and commercialize an effective, reliable, low-cost CO sensor and burner excess air control system that will counter the technical and market barriers that have resisted capturing the energy savings potential in this sector. The sensor to be developed is based on a Coen concept for an in-situ, non-extractive CO sensor using a proprietary technique to concentrate the CO absorbance signal from the stack combustion gases and thereby greatly improve the signal to noise ratio which allows accurate, real-time in-situ sampling for industrial size stacks. Coen and TIAX will develop this sensor concept and, in parallel, develop a neural network burner control system that selects burner settings and response rates based on stack conditions and prior performance for comparable load and transient conditions. This learned response capability is essential for maximizing energy savings safely and with low maintenance costs. The system will be demonstrated on a boiler and/or furnace in California and offered commercially by Coen.

Benefits

Stationary combustion equipment in California typically operates at excess air levels of 10 to 25 percent, well above the optimum level at the “knee” of the CO-O2 response curve, where further excess air reduction would cause emission of uncombustables. This optimum occurs at excess air levels of 7 to 10 percent, depending on equipment and burner design. Operating with the sensor-control system will reduce excess air levels by 5 to 15 percent for smaller equipment, and 3 to 8 percent for larger equipment (above 200MMBtu/hr). These reductions in turn translate to efficiency improvements of 0.8% for small equipment to 0.3% for large equipment. These savings, although appearing small, produce major reductions in annual fuel costs. The expected capital cost of the system is below $10,000, giving a simple payback of about 6 months for a moderate sized combustion unit. On a statewide basis, the aggregate annual natural gas firing rate of combustion equipment addressable with this system is 880 TBtu/yr. The projected energy savings for this addressable market is about 5.3 TBtu/yr, statewide. For a gas price of $8/MMBtu, this translates to an annual satewide savings of $45M. The corresponding reduction in NOx emissions due to reduced excess air and imcreased efficiency is about 200 ton/yr, statewide. These reductions would have an aggregate market value of over $1M.

Responsiveness to CEC Goals

The proposed project is strongly in the public interest because it delivers energy and environmental benefits to a wide range of California citizens. The concept is applicable to most non-engine stationary industrial and utility combustion equipment and will thereby accrue benefits through reduced costs of industrial manufacture and power generation and reduced total statewide fuel demand. Since fuel costs are typically a large fraction of manufactured costs, the project will enhance industrial competitiveness and delay the loss of business to offshore competitors. The reduced excess air demand, as well as improved efficiency will also reduce NOx emissions. Funding of this project via the Natural Gas Research Program is in the public interest because this collaborative public-private sponsorship will expedite the development and reduce time to market relative to solely private sponsorship. The potential statewide energy savings from public funding of this project thereby accelerating commercialization by 3 years is $120M.

Objectives

The overall objective is to develop, demonstrate and commercialize a low-cost sensor and control system for increasing boiler and furnace efficiency by reducing excess oxygen in combuston air. The key sub-objectives are:

- Develop the in-situ, non-extractive CO sensor through bench scale tests
- Conduct system scale-up tests in pilot-scale combustion equipment
- Develop neural network control algorithm
- Evaluate integrated sensor-control system in long-term field tests on a California boiler or furnace

The results will be a sensor-control package with a target price of less than $10,000 applicable to most natural gas-fired boilers, heaters and furnaces in California. This package will be commercialized for both retrofit and new source application by Coen Company through direct sales and alliances with OEM's, engineering companies, and field service contractors.

Budget

2005 : 700000
2006 : 700000
Other : 600000

Comments

Several industrial equipment operators in California have expressed interest in serving as host site for the sensor-control demonstration.

Project Concept #139: Reduction of Market Barriers for Combined Heat Power by Improved Interconnect Power Quality

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Description

A number of factors are inhibiting the widespread adoption and implementation of distributed energy resources where combined cooling, heating, and power (CHP) can be implemented and export electrical power to the grid. Some of these inhibiting factors include power quality, efficiency, safety and cost. To this end, the team of TIAX and Hess Microgen was selected by the Department of Energy's Distributed Energy Program in June 2004 to demonstrate an integrated combined heat and power (CHP) system that seeks to overcome some of the factors mentioned above. One key issue is that power utilities frequently object to the use of synchronous generators in areas where the grid system is limited by fault current and will not permit the installation of additional synchronous generation capacity. Furthermore, there are objections to the increased installation of inductive generators since they do not produce reactive power and therefore do not always offset grid current loading. The DOE project is investigating an innovative concept of using inverter technology to expand the market for synchronous generator use in CHP applications. The project is scheduled for installation and demonstration at a Raley's supermarket facility in Loomis, CA.

A number of issues will remain to be resolved before the commercialization of the above concept which is still at an R&D stage. These issues include, and are not limited to, optimizing system electrical efficiency, system durability and reliability, development of new/robust control systems and algorithms, and system packaging. The proposed project will target to commercialize the above described system and will thereby enable the use of synchronous generators as well as develop a strategy for exporting power to the grid which in California faces some of the above mentioned challenges.

Benefits

Successful commercialization of the proposed concept will result in lowering of key barriers for the widespread adoption of CHP systems and enabling DG of electrical power. It will also enable adequate, reliable, and reasonably-priced electrical power, especially during peak periods. Additional benefits to the public will include environmental benefits, improved energy efficiency, and reliable and reasonably priced electrical power, especially during peak periods. Incorporating electrical inversion technology with cogeneration offers two environmental benefits. First, if the prime mover is able to operate continuously, then the high exhaust emissions problem associated with start up stabilization is eliminated. Secondly, during part load operation, engine speed will be reduced which will significantly reduce the effect of noise radiation. Currently installed prime-power Cogeneration systems suffer inherent chemical to electrical energy conversion efficiency penalties when operated at off-peak part-load conditions, due primarily to the increasing significance of frictional and thermal losses and increasing pumping losses when operating at fixed shaft speed. The incorporation of high efficiency inversion technology will offset these losses by allowing the prime mover to operate at lower shaft speed during part-load operation. Overall efficiency will exceed 70% at optimal operating conditions.

Responsiveness to CEC Goals

The proposed project addresses many of the goals of the California Energy Action Plan. First, the project promotes customer owned distributed generation (DG). Secondly it will enable adequate, reliable, and reasonably-priced electrical power, especially during peak periods. Overall some key hurdles inhibiting the widespread adoption of combined cooling, heating and power (CHP) systems are lowered. The project will utilize currently available off-the-shelf inversion modules and controls which will add a relatively small incremental cost to Cogeneration systems similar to units presently being economically operated. The technology will open new markets for distributed generation and CHP which are not now accessible - many power utilities presently object to the use of synchronous generators in areas where the grid system is limited by fault current and will not permit the installation of additional synchronous generation capacity. Full time power inversion can be utilized to limit fault current contribution, which will allow synchronous

generation to be installed which is more acceptable to consumers since it offers the possibility of back-up power in case of grid failure and is therefore preferable to inductive generation even where the utility is not concerned about reactive power. Public funding for this project is needed to accelerate the time-to-market of this critical technology.

Objectives

The two most important outcomes of the proposed project concept will be:

1. Identification of a strategy for exporting power to the grid.

2. Commercial development of an enabling technology for the economically viable application of synchronous generators

Budget

2005 : 250000
2006 : 250000
Other :

Comments

Project Concept #140: A Natural Gas - Sourced Omni-Utility for Southern California

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Description

A very large floating platform, offshore Southern California, will support a 1,000 MW power plant, a 50 acre-ft./day potable water distillation unit and an advanced gas-to-liquids (GTL) hydrogen and fuels plant, as well as liquified natural gas (LNG) offloading, storage and re-gas facilities providing one billion cu. ft./day of natural gas. All will operate on LNG feedstock from tankers offloading at the rate of about three per week. The platform will be located at least ten miles offshore, where it will be invisible to an observer at the shore. Gas, electric, water and fuels products will be delivered to California consumers via buried submarine conduits, passing unobtrusively beneath the beach to meet infrastructure well inland.

The electric power station will be of the gas-and-steam combined cycle type that has the highest thermal efficiency among any in operation. The water distillation plant will work in co-generation, resulting in an extremely cost- and fuel-efficient means to produce potable water. Both are "off-the-shelf".

The GTL plant, with gas feedstock, will ultimately produce hydrogen gas for future automotive fuel while sequestering the stripped-off carbon. No CO2 need be released. Until there is a market for hydrogen, the GTL plant can produce 10,000 bbl/day of gasoline.

The platform, some 12 acres in area, will be built in pre-stressed reinforced concrete; fireproof and low maintenance. LNG storage tanks will be entirely internal to the platform structure, well separated, and protected by thick reinforced concrete decks. The platform construction is cellular, providing hundreds of air-filled compartments that, in totality, are impervious to storms, ship collision and even terrorist attack. The platform will be moored in 1000 ft. deep water by cables and pile anchors that minimally disturb the sea-bed. The platform is movable and will cost little to dispose-of, if and when its usefulness is expended.

Benefits

Southern California is critically dependent on outsiders for adequate supplies of electric power and potable water, and suffers from some the nation's highest prices for automotive fuels. Proposed is a municipal power utility "writ large"- a locally owned and/or controlled mega-utility that provides large quantities of electric power, water, natural gas and motor fuel while being strictly NIMBY and respectful of the environment. The proposed system does so very efficiently, by means of co-generation in its broadest sense, so that the cost to California consumers is competitively low.

The very large floating platform, constructed of immensely strong reinforced concrete, will be very long-lived, ensuring that its amortized capital costs will be comparably low. It will have a remarkably "light touch" on the ocean environment; emitting no material pollutants.

The inclusion of a recently developed gas-to-liquids facility allows the production of hydrogen for transport fuel, from the natural gas feed stock, while avoiding the release of carbon dioxide. While not strictly renewable, this hydrogen provides all of the associated benefits – now. The same equipment can be used to produce gasoline at a rate that will support more than 200,000 automobiles until hydrogen fuel comes of age; under community control.

Responsiveness to CEC Goals

The proposed research and development advances science and technology in the development of offshore floating platforms much larger than any in existence, and supporting several cooperating, large scale physical and chemical processes to maximize overall system efficiency and utilization while minimizing environmental impact.

In our case, the proposed program will provide critical electrical energy and water supplies under local control, not subject to market manipulations and benefiting from a buyers' market for the raw material: LNG. Also, it is decidedly NIMBY.

Both competitive and regulated entities tend to concentrate on single functions, products or technologies. They are constitutionally unwilling or unable to "get their arms around" such a disparate collection of providers as we are proposing. Further, both types of entities are remarkably risk-averse, particularly in the offshore oil and gas platforms and processes industry – despite advertising to the contrary.

The proposed system, while providing potentially large benefits to a community, amounts to "small change" for a large energy company, and unworthy of their interest. They might deign to invest, however, if only to ensure another market for their overabundant supply of natural gas.

Objectives

Ultimate objective:

Provide to Southern California consumers, businesses and industry an efficient, low cost, environment-friendly supply of natural gas, electric power, potable water and hydrogen and/or gasoline fuel – under California control.

Immediate objectives:

1. Complete a preliminary design for an offshore, floating LNG terminal supporting power generation, seawater distillation and gas-to-liquids synthetic fuels plant, in addition to LNG offloading, storage and re-gasification facilities. The study will include methods and location of construction to best benefit CA economy.
2. Demonstrate acceptable ship-to-platform relative motions in model-scale wave basin tests – to confirm and quantify the ability to directly dock a tanker to the floating platform in realistic sea conditions with motion stability adequate to use harbor-type transfer equipment with its demonstrated safety.
3. Examine all possible environmental issues related to the presence and operation of the platform, associated ship traffic and connections to shore. Quantify the discovered impacts and specify and cost any necessary remediation measures.
4. Develop a business plan for such a facility with particular emphasis on public-private partnership and ultimate benefit to California consumers.
5. Pursue permitting of the proposed facility on the basis of the above preliminary design.

Budget

2005 : 850000
2006 : 850000
Other :

Comments

Tasks include:

- Engineering preliminary design and management
- Model testing and demonstrations
- Environmental examination and remediation plan
- Siting and infrastructure planning
- Permitting
- Business development/planning
- Financing

Project Concept #141: NOx Reduction and Efficiency Enhancement by Exhaust Gas Chemical Recuperation

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Description

Hydrogen enriched natural gas (HCNG) has recently attracted attention as a fuel for internal combustion engines with very low NOx production. HCNG engines can achieve significantly lower levels of NOx without any after treatment and allow more efficient engine operation at very lean mixtures. Current projects include a HCNG fueled bus demonstration project at UC Davis, as well as several ongoing research projects focusing on engine performance and emissions at several different universities and in industry. For heavy duty applications HCNG engines may be the only viable technology for meeting the 2007 NOx emissions regulations.

The hydrogen for enrichment of natural gas is typically produced industrially and is mixed with the natural gas when vehicles are refueled. This pathway for obtaining hydrogen requires significant infrastructure for production, delivery and dispensing. An alternative pathway is reformation of natural gas into a hydrogen rich gas stream at the point of use. This pathway is referred as chemical recuperation and potentially eliminates the need for stored hydrogen and the associated infrastructure. A further refinement of this concept is to utilize waste heat from engine exhaust to provide the energy for the reformation process. This allows higher total thermal efficiency since waste heat is utilized to "upgrade" the fuel as some of the thermal energy is recaptured as chemical energy.

The project goals are to further develop the fundamental science of the chemical recuperation process. Specifically this will allow low NOx, high efficiency operation of Natural Gas Internal Combustion Engines over a wide range of operating conditions. These engines would find applications in stationary power generators and in medium and heavy duty vehicles.

Benefits

Our research has several potentially large benefits to the state of California. Hydrogen enrichment has been shown to reduce NOx emissions by sevenfold. Chemical recuperation may allow this technological benefit without development of hydrogen production, storage, and delivery infrastructure. Additionally on-board storage of hydrogen or other chemicals is eliminated reducing the potential risk to the public. Energy efficiency gains will offset the cost of implementing chemical recuperation. Further research will quantify the benefits and operability of this technology in several applications. This research also increases California's lead in researching environmentally progressive technologies for public benefit.

Another benefit of this project will be education of graduate level engineers and scientists as well as a strong outreach component to K-12 institutions.

Responsiveness to CEC Goals

Californians suffer from pollution related health effects due to NOx emissions and other pollutants from inefficient engine operation. Californians further have upcoming state and federal regulations that are not currently obtainable with standard technology. Chemical recuperation in natural gas engines is one method that has been proven to reduce NOx emissions and increase efficiency but is not yet commercially developed because of the lack of understanding surrounding this technology. Commercial development is delayed due to this lack of knowledge. Industrial investment is unlikely to fund the basic science required to fully understand and optimize these systems for the public good. The proposed project will fill this obvious gap in the knowledge surrounding chemical recuperation in natural gas engines.

Objectives

Our key objectives are to develop fundamental understanding of the chemical recuperation process to allow further development of low NOx, high efficiency engines. Specifically this study will enable low cost

simplified hydrogen enrichment technologies for exhaust gas recovery and chemical recuperation of natural gas. Our investigations will target reactor performance as measured by conversion efficiency with regards to space velocity, mixing, inlet temperature, steam to carbon ratio, and oxygen to carbon ratio parameters.

Budget

2005 : 350000
2006 : 300000
Other : 900,000
3 years

Comments

This is a 5 year project and we will be seeking partnerships with Industry to further develop the commercial technology.

Project Concept #142: Natural gas HCCI combustion for cogeneration applications

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Description

Despite its multiple benefits as an energy saving technology, cogeneration has achieved extremely small market penetration. We are proposing a brand new solution to this problem that will considerably improve electric and thermal efficiency while providing great flexibility in the delivery and return temperatures. At the same time, the technology meets the CARB 2007 emissions standards and it is inexpensive to buy and operate.

HCCI (Homogeneous Charge Compression Ignition) engines represent a new engine technology that is currently being developed due to its high efficiency and low emissions. HCCI combustion is fundamentally different to combustion in spark-ignited (SI) engines and diesel engines. HCCI combustion is a thermal autoignition of a premixed fuel-air mixture, with no flame propagation (as in SI engines) or mixing-controlled combustion (as in diesel engines). We can take advantage of this fundamental difference in the combustion process to develop HCCI engines with optimum operating characteristics for CHP.

HCCI engines are more efficient than any other combustion engine technology that is capable of meeting the 2007 CARB emissions standards. The only other possibilities are inefficient stoichiometric natural gas engines (<34% thermal efficiency) and inefficient, expensive microturbines (~28% efficiency, $1400/kW). Fuel cells have an extremely high cost ($5000-$10000/kW) and unproven long-term efficiency and durability. Lean burn SI and diesel engines do not meet the 2007 CARB standards because lean aftertreatment technologies (i.e. SCR) are not considered economically viable for units under 1 MW. HCCI engine efficiency has been demonstrated at over 40%.

Benefits

HCCI engines offer an unmatched degree of flexibility in meeting specific temperature targets for cogeneration. They can operate at high delivery and return water temperatures. SI engines are limited in the allowable delivery and return temperatures due to knock. With HCCI engines, delivery and return temperature can be tuned to exactly meet the temperature requirements of the CHP system. For example, an HCCI engine can be set to run with the delivery and return temperatures that optimize absorption chiller performance.

HCCI engines can have a significantly higher quantity and quality of waste heat recovery than spark-ignited engines. SI engine operation is limited by knock. To avoid knock, SI engines require the use of an intercooler to reduce intake temperature. Heat transfer in the intercooler occurs at low temperature, and it cannot be used for CHP and is therefore wasted.

HCCI engines have low capital and maintenance cost. HCCI engines do not require spark plugs or high pressure fuel injectors, therefore reducing capital and operating costs.

Responsiveness to CEC Goals

We will team up with academic institutions, recognized technical experts, with Ricardo Engineers, a major provider of consulting services to the engine industry, and with York, a major supplier of CHP equipment to demonstrate the applicability of HCCI engines for CHP. This partnership will allow us to deliver on our ambitious technical goals, and will provide a direct path to commercialization of the technology.

We have calculated that a 200 kW HCCI engine attached to a CHP system results in savings of over $150,000 per year of the cost and over 30% of the natural gas that would be required to separately provide the same amount of heating and cooling.

This project will demonstrate the technical feasibility of HCCI engines for CHP, providing manufacturers with a brand new option for power generation and cogeneration. We consider that this

technology can be commercialized by the year 2010. We anticipate a fast market penetration due to the multiple benefits of HCCI engines for CHP.

Objectives

This project will demonstrate the multiple benefits of HCCI engines for CHP by delivering an engine and heat recovery system optimized for operation with an absorption chiller. The optimum system will have low emissions, low fuel consumption and low cost, contributing to meet the CEC goal of reduced cost to ratepayers.

We are planning to start with a 6 cylinder, 15-liter Caterpillar 3406 engine. We will start by finding an optimum way to match an HCCI engine with an absorption chiller.

We will modify the HCCI engine to operate at the optimum condition. Potential modifications include changing the compression ratio, replacing the turbocharger, removing the intercooler and incorporating heat exchangers in the exhaust and in the exhaust gas recirculation (EGR) loop. The system will be fully instrumented to determine temperatures and pressures in all relevant locations. We will also develop a controller that will allow us to vary the load to satisfy the demand for power and cooling. We will verify efficient HCCI operation and waste heat delivery for optimum absorption chiller operation. We will then tune the engine to improve system efficiency.

At the end of the project we will deliver an HCCI engine and heat recovery system that is optimally integrated for operation with an absorption chiller. The HCCI engine will have a high electric efficiency (37%), low cost ($700/kW), low emissions (70% of CARB 2007 NOx emissions) and high return and delivery temperatures (~120C, 248F).

Budget

2005 : 600000
2006 : 600000
Other : 600000

Comments

We are well recognized as leaders in HCCI engine technology. We have developed the most advanced analysis tools for HCCI engines. We have operated multiple engines in HCCI mode and are currently working on a CEC-sponsored project that will deliver an HCCI

Project Concept #143: Improved NOx reduction from small engines

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Description

There are no low NOx engines for generators less than 350 kW. Catalytic converters do not work. Other approaches must be tried.

Benefits

Will allow projects to be built. Fugitive methane emissions will be reduced.

Responsiveness to CEC Goals

NOx reduction requirements could derail 80% of the 1,800 potential diary digesters in CAlifornia.

Objectives

Reduce NOx from commercially available naTURAL Gas engines.

Budget

2005 : 200000
2006 : 200000
Other :

Comments

Project Concept #144: Emissions Control Systems For CHP Generation

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Description

Hess Microgen, LLC (HM) packages and Markets Combined Heat and Power Generators typically using spark ignition, Natural Gas fueled, reciprocating piston engines and is the US market leader in the sub 500kW range. California is the prime market area for HM and units constructed for that market are fitted with industry standard engine controls and after-treatment devices to ensure compliance with mandated CARB and AQMD emission limits. CARB has proposed, and will implement, new emission standards for stationary sources in 2007, aimed at improving air quality. The proposed standards will reduce permissible emissions of NOx by approximately 80% and CO and VOC's by approximately 80%, requiring similar levels of improvement to the existing emissions controls or, alternative control technologies. Failure to meet these proposed standards will eliminate reciprocating piston engine generators from the Californian market, severely compromising the overall deployment of distributed generation.

Improvements to the industry standard technology for emission control (stoichiometric operation with three way catalyst reduction), in the sub 500kW range will potentially achieve the desired goals, however, compliance will be sensitive to variability in gas composition, engine operating conditions, wear etc and efficiency penalties are likely to be incurred. Also, per unit installation and maintenance cost will be high and packaging will be problematic, all of which mitigates against continued development of the existing control system.

HM has performed a review, with outside contractors, to establish a list of technologies that could meet 2007 emission standards without incurring the penalties associated with developed versions of the existing systems and has performed some preliminary scoping experiments to investigate the most likely candidates. HM would like to continue research in the field of emissions reductions, with the goal of developing and productionizing a robust engine control and after-treatment system. The complete system would be capable of reliably meeting 2007 emission standards without impacting efficiency, in an economical and reasonably sized package. Incorporating this control system into CHP units would safeguard the continued deployment of distributed generation into the California market place.

Benefits

The emissions reductions goals of this project are clearly defined in the CARB 2007 stationary source regulations and will result in an 80% reduction in NOx and 90% reduction in CO and VOC’s from natural gas fired, distributed generators. Meeting the targeted goals will allow California to benefit from continued deployment of fuel efficient CHP generation systems, many of which include the additional efficiency benefit of combined chilled water supply. The efficiency benefit of CHP generation, compared to central power plants, can be as high as 100% in terms of overall recovered energy with an equivalent reduction (50%) in CO2 emissions.

Responsiveness to CEC Goals

We believe this project meets the definition of “public interest” primarily by ensuring the continued deployment of distributed generation within California, which will help meet the energy requirements of its citizens and businesses. The financial costs of developing an effective 2007 emission control system are considerable and may render the California marketplace unprofitable to manufacturers of sub 500kW CHP generator systems. Although HM is currently investigating methods for meeting the proposed regulations, we are not confident that we can economically meet the requirements within the allocated time frame without additional funding. Successful completion of this project will help to improve air quality and reduce energy costs by improving efficiency through the continued use of CHP generation. Increased deployment of distributed generation also improves the reliability of the utility electrical supply by

reducing peak loads and offers the possibility of independent power back-up to critical loads in the event of utility failure.

Objectives

The outcomes and goals of this project are 1) To identify candidate engine control and after-treatment systems and to evaluate and rank candidates by technical and financial factors, such as; risk, conversion efficiency, size, etc. 2) To perform initial evaluations of the most promising system candidates, either with modeling routines or by empirical analysis. 3) To continue development of the best control system, including performance testing over the complete engine operating cycle. 4) To design and develop a pre-production control system for durability and pilot testing. 5) To develop a fully productionized control system for fitment to new HM Californian generator units which will effectively and continuously meet 2007 emission levels.

Budget

2005 : 225000
2006 : 225000
Other :

Comments

Project Concept #145: Gasification Based Power as a Hedge Against High Natural Gas Prices

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Description

This project will consider a wider application of Integrated Gasification Combined Cycle (IGCC) power plants in California as a hedge against high natural gas prices and overdepence on natural gas as a fuel source. Consideration will be made for coal, coke, and biomass feed for gasification facilities as a way to produce clean power from more price stable feed sources.

Diversifying California's electricity portfolio has become more important in recent years due to the high price of natural gas. One technology that has been neglected is the wider use of gasification technologies, which could supply a large amount of clean power at competitive prices. New gasification technologies are proving their environmental benefits by reducing NOx, SOx, and mercury emissions, and being carbon dioxide "sequestration ready". Signficant research is being performed in California for the potential to reduce carbon dioxide emissions through geologic sequestration. No other type of power plant is as well suited to carbon dioxide removal and sequestration as IGCC.

This study would compare the installation of IGCC power plants versus natural gas combined cycle (NGCC) for the next generation of California power plants. Performance, location, economic, and environmental impacts will all be considered to determine the scenarios most favorable for each technology. Previously developed economic and performance models will be used in this analysis, with information specific to the California market included.

Benefits

Modern IGCC facilities have shown they can meet the following performance goals:

- NOx < 0.05 lb/MMBtu
- Particulates < 0.005 lb/MMBtu
- Mercury > 90% removal
- Thermal Efficiency = 45-50%
- Capacity factor = 85%

Besides these criteria, IGCC facilities can also play a leading role in sequestration of carbon dioxide. Capture and removal of carbon dioxide can be performed in the pre-combustion step of an IGCC, reducing cost and complexity versus flue gas removal in NGCC facilities. This technology should also be considered relative to the impacts that NGCC facilities will have on carbon dioxide emissons.

Recent studies have also attempted to quantify the cost of IGCC facilities of various scales for power generation and clean fuels production. Large scale IGCC plants could potentially produce power in the range of 5 cents/kWh. In addition, these facilities could produce clean transportation fuels suitable for use in the California CARB diesel and gasoline markets. The large capital costs and relatively new technology remain potential barriers for widespread commercialization. However, project currently being considered for completion in the next 10 years make this technology an excellent candidiate for use in California as a hedge against high natural gas prices.

Responsiveness to CEC Goals

By considering the economic and environmental impacts of future large-scale power plants in California, this project will meet the CPUC's definition of public interest. Options are being considered that can be beneficial to the prosperity and environmental well-being for the state's citizens. This project considers the broader question of how the projections for future natural gas prices should shape the power market in California. The project also considers items critical in the Governor's Natural Gas Working Group by considering options available as a hedge against high natural gas prices. The use of widely available coal, petroleum coke, or biomass fuels on a broader scale than has currently been performed with modern gasification technology has not been properly evaluated. The public interest is served by

California decision makers considering all available technology options for large-scale clean power production.

Objectives

The key objectives will be a direct comparison of IGCC and NGCC power plants for the next generation of large California power plants. A variety of feeds (different coal types, refinery coke, and different types of biomass feeds) and performance characteristics (use of sequestration equipment and co-production of clean fuels along with electricity) will be considered versus NGCC design. The key deliverable will be a range of suggestions for the use of IGCC technology that would be favorable on an economic and environmental basis relative to the use of natural gas. The CPUC can use this data in determining the most suitable criteria for evaluation of future large scale power plants, and to determine if IGCC technology could be useful for reducing California's reliance on natural gas.

Budget

2005 : 250,000
(6 months)
2006 : 0
Other :

Comments

Project Concept #146: Commissioning and Diagnostics Methods and Tools for Gas-fired Equipment and

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Description

HVAC systems in many commercial buildings fail to performance at or near their potential due to a variety of operational problems and gas-fired equipment and systems are no exception. This problem can be addressed by commissioning, to bring the systems into a state of correct operation, followed by continuous monitoring to detect problems as they arise during routine operation. There is a need to develop methods and tools for manual use by commissioning agents and building operators. There is also a need to develop automated commissioning tools to assist commissioning agents and reduce the cost of commissioning. Automated diagnostic tools are needed for buildings that have no operators or have operators that have insufficient time or skill to monitor equipment operation continuously.

The program should support the development, testing and demonstration of commissioning, monitoring and diagnostic methods and tools for heating systems, gas-powered cooling systems and gas-powered on-site electricity generation systems, from individual items of equipment to integrated systems that combine heating, cooling and electricity generation. Absorption cooling integrated with micro-turbines or fuel cells is of particular interest because of its demand response and load-leveling potential as well as its potential to increase overall energy efficiency because of the opportunity to utilize the 'waste' heat rejected in the electricity generation process. The work should complement, and integrate with, the corresponding work already supported by PIER for electrically-powered HVAC systems.

The tools should be capable of being used with the majority of existing control systems currently used in commercial buildings and should be consistent with current divisions of responsibility between different professionals and trades and the associated business models. The tools should also identify the costs incurred by continued faulty operation and the expected cost of remedial action in order to provided building operators and managers with a rational basis for responding to the faults identified by the tools.

Benefits

The public would benefit from this proposed field of research for the following reasons.

1. Extension of methods and tools currently under development for electric-powered equipment and systems will enable gas-powered equipment and systems to operate more efficiently and reliably, providing an alternative that is more efficient that the current most efficient solution in some cases.

2. Gas-powered cooling equipment is often perceived as unreliable as well as unconventional, which mitigates against equipment and system selection based on efficiency considerations. The reduction in energy consumption resulting from the selection of more efficient equipment results in economic and environmental benefits to both the user and the State of California. Diversity of fuel use benefits the public by reducing the vulnerability to price rises and supply shortages associated with reliance on any one source of energy.

3. Promoting increased selection of gas-powered cooling equipment will reduce peak electricity demand, which benefits building owners directly through reduced exposure to potentially increasing demand charges and indirectly through reduced generation, transmission and distribution charges. It also benefits all consumers by improving load shapes, resulting in more efficient use of capital investment in generation, transmission and distribution equipment

Responsiveness to CEC Goals

Use of public funds to develop commissioning and diagnostic tools for gas-fired components and systems will be in the public interest for the following reasons:

1. The methods and tools will be available to all equipment and controls manufacturers, maximizing the opportunities for adoption and widespread deployment.

2. Publicly funded research can address the needs and interests of building owners and help to create market demand for commissioning and diagnostic tools, making it more likely that multiple manufacturers will respond by implementing and commercializing the technology. Creating market demand helps to counteract the problem that deployment of diagnostic tools may conflict with the business models of some manufacturers and contractors who either want to avoid owners being made aware of poor performance or do not want owners to be able to diagnose and fix problems by themselves.

The US DOE currently supports the development of automated diagnostic methods and tools. US DOE would be a potential source of matching funds for this type of project

Objectives

1. Develop functional test procedures for use in both manual and automated commissioning of gas-fired equipment and systems.

2. Develop both manual monitoring and automated diagnostic methods to identify faults in gas-fired equipment and systems during routine operation

3. Implement these methods in tools that are adapted to the needs and skills of the intended users.

4. Test, improve and demonstrate these tools in a range of building types and practitioners.

Budget

2005 : 500000
2006 : 500000
Other : 1500000

Comments

Project Concept #147: Improved integration of HVAC heating and cooling in California commercial buildings

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Description

Simultaneous heating and cooling in large commercial buildings has been a recognized problem in building control for a long time. It is a serious problem particularly in California because the mild weather and long swing seasons. Anecdote evidences from the field suggests that most of large commercial office buildings have certain levels of simultaneous heating and cooling. The problem is so widely spread that very few buildings can add in any interlock between boiler and chillers to prevent them running simultaneously while not causing comfort problems.

Simultaneous heating and cooling not only wastes gas heating, but also electricity for cooling. In general, there are four types of problems.

1) Simultaneous heating and cooling in a given zone at the same time. This is a particular problem for single duct VAV with baseboard heaters, or with foot heaters controlled by building occupants. Poor zoning in design is the major cause. Zones with very different load profiles are inappropriately served by a single air-handling-unit.

2) Simultaneous heating and cooling in difference zones at the same time. This is so common that it has come not to be regarded as a problem by building operators and design engineers. However, taking the building as a whole, it is still running boilers and chillers at the same time. Unnecessary simultaneous use of chillers and boilers can be avoided by providing a certain amount of air mixing between zones requiring cooling and zones requiring heating.

3) Switching between heating and cooling modes in the course of a single day. It is quite common that for a building to be in heating mode in the early morning while being in cooling mode for the rest of the day. This can be minimized through appropriate controls and better use of building thermal mass.

4) Simultaneous heating and cooling caused by faulty equipment or bad controls.

Benefits

The public would benefit from this proposed field of research for the following reasons.

1. It will reduce the chance of poor design and bad zoning in new buildings and improve the awareness of design engineers on the importance of the inter zone air mixing and better zoning.
2. The detection tool will help building operators and commissioning agents identify the problem and reduce gas and electricity usage in exiting buildings.
3. It will reduced energy source air pollution related to building heating and cooling

Responsiveness to CEC Goals

This research will reduce the use of the gas heating and electrical cooling both for existing and new large commercial buildings. Use of public funds to investigate the simultaneous heating and cooling problems and develop tools and methods to mitigate the waste will be in the public interest for the following reasons:

1. The software tools will be available to all building operator and engineers, maximizing the opportunities for adoption and widespread deployment.
2. Publicly funded research can address the common needs and interests of building owners and help to create market demand for better designs and building controls.
3. The stock analysis will increase the public awareness of the problems of simultaneous heating and cooling and improve design and control practice in the industry. The simultaneous heating and cooling problem does not belong to certain manufactures or consulting firms. Private firms gain no direct financial benefit from this type of study and have no incentive to invest on it.

The US DOE currently supports the development of building fault detection tools. US DOE would be a potential source of matching funds for this type of project.

Objectives

The objectives of the research is to better understand the magnitude of the problem and develop better design concept and diagnosis tool to avoid simultaneous heating and cooling both in design phase and operation phase.

1) A stock analysis to understand the magnitude of the problems in California and estimate potential savings
2) Develop a software tool that help designers to improve zoning and inter zone air mixing, and avoid the simultaneous heating and cooling in new buildings through improved design.
3) Develop a software tool to detect simultaneously heating and cooling in existing buildings. The detection tool could operate both at the whole building level and at the HVAC component level. The whole building level tool will be more likely to detect control problems and the component level tool will be more likely to detect equipment failure.

Budget

2005 : 200000
2006 : 200000
Other :

Comments

Project Concept #148: Optimizing Energy Use and Minimizing Energy Savings Uncertainties: Cost-Effective Quality Assurance

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Description

Uncertainty about the ability to achieve and maintain energy savings is one of the major stumbling blocks encountered when seeking to displace or defer new energy supply investments with "downstream" improvements in energy efficiency at the point of use. Moreover, energy use in "typical" buildings is also often higher than necessary due to pervasive failures in the design, application, and/or operation of commonplace energy-using systems.

As evidence of the problem, a soon-to-be-released USDOE review of experience in 225 commercial buildings (representing 30 million square feet of floor area) shows that actual savings from the installation of energy-efficient technologies routinely fall well below predictions. The median value for this sample was 15% excessive energy use--although many cases ranged as high as 50% under-achievement of targets—with average payback times of less than one year. Underpinning this result are thousands of instances of improperly designed or malfunctioning building systems, ranging from broken fans to improperly programmed building automation systems.

This situation has important implications for individual building owners, seeking to recover optimize investments as well as for policymakers for whom strategic statewide energy goals are often not reached. A systematic approach to quality assurance (known as "commissioning" for new buildings and "retro-commissioning" for existing ones) has been shown to recapture these lost opportunities by identifying and remedying hardware and software deficiencies. However, Building owners routinely cite lack of information on (retro)commissioning cost-effectiveness as top barrier to uptake in the real world.

Results of FY04 background work are already being sought by California decision-makers (e.g. Los Angeles County using to justify planned retro-commissioning of two million square feet of public buildings). The Sate of California's Green Buildings Initiative is also utilizing the results.

Benefits

One task within the project will be to develop a detailed energy savings potential analysis for commissioning and retro-commissioning California. Our preliminary estimate is that the cost-effective savings potential is at least 15% of the natural gas use in California commercial buildings. Very significant additional non-energy benefits, ranging from capital cost savings from detecting and correcting design flaws in new buildings, to avoiding premature equipment failure, to reduced indoor air quality problems. These ancillary benefits will be quantified within the project to the extent possible.

Responsiveness to CEC Goals

1. Energy efficiency, renewable technologies, conservation and environmental issues:

By addressing pervasive hardware and operations problems, commissioning offers more savings and environmental benefits than most single hardware measures designed to reduce energy use in commercial buildings.

2. Support State Energy policy:

The proposed work has very direct relevance to "Goal 1 -- Optimize Energy Conservation and Resource Efficiency". Energy conservation clearly cannot be optimized without commissioning.

3. Offer a reasonable probability of providing benefits to the general public:

By improving our understanding of commissioning and advancing the most effective techniques, this project will reduce the risk of failure across the entire spectrum of energy-efficiency strategies while independently enhancing the performance of ordinary buildings that are not particularly energy efficient but are, nonetheless, using more energy than necessary.

4. Opportunities for collaboration and co-funding:

Commissioning is integral to national deployment programs including ENERGY STAR Buildings and LEED. Local governments and NGOs in California are also engaged with the topic. The California Commissioning Collaborative--formed by utilities and the CEC to bring together public and private stakeholders—is developing the market for commissioning services. Commissioning practitioners have offered to share data for the proposed analysis.

Objectives

Most prior work on commissioning has centered on electricity savings, yet available evidence suggests considerable potential for gas end uses. The proposed activity would apply a data-collection and analysis framework developed for the U.S. Department of Energy in 2004 to natural-gas usage in California commercial buildings. Emphasis would be placed on cost-effectiveness analysis – as this is the prime barrier to market acceptance. A large number of commissioned buildings (including standard office buildings, schools, hospitals, and public buildings) have been identified in the State for which real-world data are available to be gathered and analyzed. Best-Practice briefs, based on the results, would be developed and disseminated among the stakeholder communities. Energy R&D planners would also learn which existing and emerging natural-gas technologies are most susceptible to performance problems, and thus enabled to take proactive and focused steps through technology development as well as education and training for key actors. Similarly, specific building types with the most promise would also be identified.

Budget

2005 : 150000
2006 : 100000
Other :

Comments

Project Concept #149: Intrinsically Safe Gas Sensor

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Description

The project introduces a new infrared sensor technology for the detection and measurement of methane (CH4) for two different applications:

Concept 1:

The gas sensor will be used for the remote inspection/monitoring of gas leaks along the gas distribution system providing a new control technique between the field and utilities control centers. The microminiature sensor is a highly engineered instrument based on a proprietary infrared technology using optical and acoustic effects. The sensor can be deployed for unattended operation in remote gas distribution nodes, providing round-the-clock, high-speed measurement and notification in real-time.

While monitoring the atmosphere in confined sites, the sensor acts as early warning device, able to measure small gas concentrations before hazardous conditions can build up. At any programmed level, the sensor instantaneously notifies the operation control center via Remote Terminal Units through wired, wireless or internet communication capabilities, providing an assessment of actual leak conditions before dispatching personnel to repair the gas leak in a timely manner.

Low concentration range: 0 to 5 volume%, or 0 to 100% of the Lowest Explosion Limit (LEL)

Concept 2:

The gas sensor will be used to control and automate the collection of biogas and the operation of distributed power generators (e.g. microturbines and fuel cells), i.e. to control the operation of power systems based on actual gas concentration, to achieve the highest possible conversion efficiency. The implementation of the sensor technology in landfills, also in water & waste water treatment plants, food manufacturing and processing, and livestock manure plants will improve the biogas-to-electricity conversion efficiency, enhance system reliability and lower operation and maintenance costs, thereby increasing the value, cost competitiveness of biogas-to-electricity systems.

Goal: Optimize the process of biogas-to-electricity conversion via a cutting edge sensor technology.

High concentration range: 1 to 100 volume %. Please note the CH4 concentration in biogas fluctuates between 30 and 70 volume %.

The low power sensor (< 1 watt) shall comply with the National Electric Code Standard NEC 500, in order to be used in classified/hazardous locations. Target certification: Intrinsically safe Class I Division 1, Groups ABCD NEMA 4

Benefits

Concept 1:

In contrast to current (manual) inspection methods, the new sensor will provide the essential information: Where and how large is the gas leak, as soon as it occurs, and the prompt notification will enable the systematic and timely repair of detected leaks. The timely leak detection will contribute in reducing methane emissions, a potent greenhouse gas (GHG) and a major contributor to global warming. Further, in consideration of the very high incidental costs, the gas sensor will contribute reducing the explosion risk - merely a 5 volume-% of methane in air is a potentially explosive atmosphere -, thus providing actual safety to employees and the general public.

Economic/Operational Benefits:

- Save up to 70% of current inspection costs and eliminate existing inspection infrastructure
- Conserve up to 80% of lost gas inventory by keeping leaked gas in the system for sales
- Achieve an Internal Rate of Return (IRR) above 40% and payback in less than 2 years
- Eliminate useless crew interventions to optimize the productivity of human and capital assets.

Concept 2:

- Maximize biogas recovery efficiency and systems run time for electricity production
- Increase the conversion efficiency of power generators by an estimated rate of 10 to 15%

• Reduce related O&M costs by an estimated 20%, thus improve the productivity of human/capital assets
• Reduce scrutiny - determine the correlation between the quality of biogas and power output
• Reduce the risk of biogas migration and associated environmental control/compliance costs

Responsiveness to CEC Goals

The concepts 1 and 2 described above are in match with the criteria listed in the invitation. The sensor provides a wide range of environmental, energy efficiency and economic benefits. Indeed the sensor will contribute in:

1) Reducing the emissions of methane, a potent greenhouse gas, thus improving the environmental quality (concept 1 & 2)

2) Timely repair of gas leaks, thus enhancing the gas distribution system reliability (Concept 1)

3) Adequate use of abundant renewable energy resources (biogas) and maximize gas-to-electricity conversion efficiency, thus improved energy efficiency (concept 2)

4) Improving the safety of the general public (concept 1 & 2)

Objectives

Commercialization of a cutting edge technology that can be used in:
Concept 1 (natural gas distribution system)
• Compressor Stations
• Field Compressors
• City Gate Stations
• Pressure Regulator Stations
• Service Regulators
• Gas Fired Power Plants
and
Concept 2 (Use of biogas for green power)
• Landfills (landfill gas)
• Waste water treatment plants
• Farms (biogas from livestock manure)
• Food manufacturing and processing plants
Targeted sensor features:
• Microminiature, low power sensor (less than 1 watt)
• Advanced environment-compensatory tools to be immune to deceptive gases and phenomena
• Multiple plausibility checks, self-diagnostic/built-in-failure-sensing tools for improved measurement accuracy
• Proportional-Integral-Derivative algorithms to capture trends and concentration change rates
• Open communication architecture: Versatile for integration into host control systems and Remote Terminal Units
• Bi-directional: Remote programming and diagnostic through integrated self-test capabilities

Target Specification:
• Measurement Range: 0-100% LEL (also 0-100 volume-%)
• Repeatability: 1-2% Full scale
• Long Term Stability: < 1% Full scale
• Operation Temperature: -20 to 50 °C (temperature compensated)
• Operation Humidity: 5 to 95% RH
• Power Consumption: < 1 Watt
• Product Approvals: UL, Class I, Division 1, NEMA-4
• Expected Life Time: 10-15 years

Budget

2005 : 400000 2006 : 300000 Other :

Project Concept #150: Optimize Gas Engine Emission Reduction Strategies

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Description

Large natural gas engines are used to transport natural gas throughout California. These engines ensure that a reliable supply of natural gas is available for local consumption as well as power generation.

There are several engine emission reduction strategies that are available. However, little to no work has been completed to optimze the impact and determine the synergies of combining the technologies for a given engine configuration.

The most effective technique that is available to optimize these technologies is to utilize engineering models of the engines and technologies, and then use these models as part of an optimization algorithm. The goal of the project is to identify the most promising technologies, and then additionally identify the synergies developed by combining technologies on an engine.

These same technologies may also be applicable to gathering and transportation engines. Hence, this project has cross-cutting possibilities.

Benefits

The heat rate of these engines is expected to improve by 8-10%. Individual technologies have shown some improvement in engine efficiency, thereby lowering the energy required to transport natural gas. By combining and optimizing various technologies, expectations are that engine efficienfcies can be increased from about 305 to as high as 38%.

The emissions impact is a double win. First, by increasing engine efficiency lower amounts a natural gas are combusted to transport the same amount of natural gas through the pipelines. By burning a lower amount of fuel, the emissions are automatically reduced. Second, the emission reduction strategies themselves will lower the emissions from the optmized engines. Expectations are that NOx emissions can be lowered to sub 1.0 g/bhp-hr level in a very low-cost way.

Responsiveness to CEC Goals

This project is definitely in the public interest. By identifying combinations of emission reduction strategies, and optimizing those strategies, the public will benefit from lower-cost natural gas and, in turn, electrical production. Additionally, the emissions from the large gas-driven engines used to transport natural gas will be significantly lower than with the individual technolgoies used today. Finally, by using models of the engine systems and emission reduction strategies, literally hundreds of combinations can be tested in a short period of time. Hence, this represents a very low-cost althernative to actual field tests of emission reduction technologies.

Objectives

1. A menu of gas engine emission reduction strategies that can be applied to multiple engine sizes and models.

2. Potential to significantly reduce emissions from gas engines with a combination of low-cost emission reduction technologies

3. Reliable and cost-effective natural gas transportation within the State of California

Budget

2005 : 150000
2006 : 150000
Other :

Comments

An engineering model, the Turbocharger-Reciprocating Engine Simulation, has been developed through funding from the gas transmission industry over the last four years. This model has been used to optimization strategies, and is currently being used to fur

Project Concept #151: Rapid Post Earthquake Damage Information Collection

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Description

Earthquakes provide actual laboratories for documenting damage to utility systems. This subtask will provide contingency funding for a utility team and other investigators to document damage immediately after an earthquake. Tasks would include 1] investigations of fire occurrence that may be related to natural gas to assess the root cause of fires (including ignition and fuel sources) and contributions of natural gas to fires following an earthquake 2] investigations of the impacts to and the number of utility customers affected by gas service outages and the length of restoration times 3] impact of natural gas shut off valves 4] performance of natural gas transmission and distribution systems in communities affected by the earthquake 5] post-earthquake engineering evaluation of natural gas pipelines, and 6] use of information technology and recorded ground motion for post-earthquake near real time identification of potentially vulnerable sites for natural gas pipelines. A plan for post-earthquake investigations will be developed with appropriate protocols and agreements among participating utilities in consultation with the PEER Lifelines Advisory Panel. Field-documentation formats and a report database will be developed in advance and installed on a portable computer. Use of modified USGS ShakeMaps will be examined for post-earthquake damage assessments in near real-time.Potential Partners for collaboration in this research include the CA utilities, other lifelines organizations and the Earthquake Engineering Research Institute (EERI).

Benefits

Ultimately, the implementation of PEER Lifelines research by the utilities contributes to the goals of public safety as well as local and state economic resilience by minimizing the costs and impacts associated with utility disruptions after major earthquakes and other natural disasters. Rapid restoration of natural gas service after future earthquakes has been identified as a high priority by business and residential sectors. The results will also have initial impact in improving emergency response plans and preparations. The public interest will also benefit by having research results available for use by other infrastructure agencies, such as co-funders of this research, and the general business and residential communities potentially affected by earthquakes

Responsiveness to CEC Goals

There are no identified competitive benefits of this research; on the contrary, there is on-going interest in cooperative efforts among the utilities to improve earthquake performance. Research results are widely circulated within the utility setting, among appropriate state agencies, and in the scientific and engineering literature. The CEC, as a regulator and reviewer of new energy projects in California, would benefit by the availability of improved seismic hazard information. As the regulator of safety and reliability of the gas utility and transmission and distribution systems, the Public Utilities Commission (PUC) has been supportive of utility-initiated efforts to define performance levels and to improve seismic safety and reliability, and has not established seismic criteria independent of those used by the major utilities, which would benefit from the proposed type of research.

Objectives

Protocols and agreements between participating utilities for post-earthquake damage assessment. Following a significant earthquake, field investigation results will be compiled in comprehensive report for the Commission and the Public Utilities Commission. The reports will include the potential use and applications of the information technology and Internet for post-earthquake rapid damage assessment of pipeline systems.

Budget

2005 : 230000
2006 :
Other :

Comments

Project would establish contingency funding for post-earthquake investigations.

Project Concept #152: Natural Gas Seismic Safety and Reliability - Geotechnical

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Description

Ground deformation associated with fault displacement, liquefaction and landsliding are the primary causes of damage to buried gas lines and other utilities during earthquakes and winter storms. Research in this topic area will focus on the development of methodologies to quantitatively characterize fault offsets (amount, width of zones, displacement profiles, direction and geometry), liquefaction susceptibility and probabilities for liquefaction during earthquakes, and probabilities for hillside failure during earthquakes and rainfall events. Information on these geologic demands will also be used to 1] develop simplified procedures for estimating displacement demands on buried structures 2] calibrate and benchmark nonlinear dynamic ground deformation models to improve performance based design procedures for buried pipelines and utility facilities and 3] providing input for real-time response and recovery efforts following natural disasters using GIS-based technologies.

Benefits

Ultimately, the implementation of PEER Lifelines research by the utilities contributes to the goals of public safety as well as local and state economic resilience by minimizing the costs and impacts associated with utility disruptions after major earthquakes and other natural disasters. Rapid restoration of natural gas service after future earthquakes has been identified as a high priority by business and residential sectors. The results will also have initial impact in improving emergency response plans and preparations. The public interest will also benefit by having research results available for use by other infrastructure agencies, such as co-funders of this research, and the general business and residential communities potentially affected by earthquakes

Responsiveness to CEC Goals

There are no identified competitive benefits of this research; on the contrary, there is on-going interest in cooperative efforts among the utilities to improve earthquake performance. Research results are widely circulated within the utility setting, among appropriate state agencies, and in the scientific and engineering literature. The CEC, as a regulator and reviewer of new energy projects in California, would benefit by the availability of improved seismic hazard information. As the regulator of safety and reliability of the gas utility and transmission and distribution systems, the Public Utilities Commission (PUC) has been supportive of utility-initiated efforts to define performance levels and to improve seismic safety and reliability, and has not established seismic criteria independent of those used by the major utilities, which would benefit from the proposed type of research.

The California Department of Transportation (Caltrans) has committed $ 2,250,000 in funding over five years for the performance of common-interest seismic research in the PEER Lifelines Program.

Objectives

PEER Lifelines Program objectives will address natural hazards issues for natural gas transmission and distribution systems. Geotechnical research conducted under this program will provide utility owner/operators the ability to determine the impact of geologic hazards (such as fault offset, liquefaction and ground failure, and weather-related landsliding) on gas transmission and distribution systems. Integration of research results in a Geographic Information System (GIS) framework will provide the ability to overlay gas network information with either scenario or real-time USGS ShakeMaps of peak ground acceleration or maps of liquefaction or weather-related landslide probability to determine priorities for replacing vulnerable pipeline and identify potential problem areas immediately after seismic events or

winter storms. Research on earthquake fault rupture will provide a tool for geotechnical engineers and geologists to better characterize system-wide fault displacement hazards, estimate relative degrees of risk, and prioritize fault crossings for mitigation

Budget

2005 : 600000
2006 : 500000
Other : 500000

Comments

Project Concept #153: Natural Gas Safety and Reliability - Pipeline Mitigation

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Description

Project objective is to develop and validate cost-effective practical solutions to ground deformation problems related to buried pipelines and other underground facilities. The following steps will be taken:

1] Multi-disciplinary advisory experts are selected to form an expert panel to advise the project. The panel will include seismologists, geotechnical engineers, structural engineers, mechanical engineers, utility engineers, among others.

2] Available engineering mitigation strategies to avoid failure if underground structures, especially underground pipelines, will be compiled, summarized, and evaluated. The existing mitigation strategies will be prioritized based on their effectiveness, applicability to natural gas, and cost.

3] If needed, new mitigation strategies are identified. This process will be monitored by the advisory expert panel in collaboration with the PI. The identified new mitigation alternatives are examined either by the PI, or sub-award(s) will be issued to other experts to examine the details and effectiveness of the mitigation alternatives.

4] Existing and new mitigation alternatives will be reviewed in light of seismic performance of buried structures in previous earthquakes.

5] Final existing and new mitigation strategies will be prioritized in terms their effectiveness, applicability to natural gas systems, and cost.

6] Application guidelines will be written for each mitigation strategy.

7] The application guidelines will be posted on PEER web site for public use.

8] A technical workshop will be organized to disseminate the application guidelines

Benefits

Ultimately, the implementation of PEER Lifelines research by the utilities contributes to the goals of public safety as well as local and state economic resilience by minimizing the costs and impacts associated with utility disruptions after major earthquakes and other natural disasters. Rapid restoration of natural gas service after future earthquakes has been identified as a high priority by business and residential sectors. The results will also have initial impact in improving emergency response plans and preparations. The public interest will also benefit by having research results available for use by other infrastructure agencies, such as co-funders of this research, and the general business and residential communities potentially affected by earthquakes.

Responsiveness to CEC Goals

There are no identified competitive benefits of this research; on the contrary, there is on-going interest in cooperative efforts among the utilities to improve earthquake performance. Research results are widely circulated within the utility setting, among appropriate state agencies, and in the scientific and engineering literature. The CEC, as a regulator and reviewer of new energy projects in California, would benefit by the availability of improved mitigation information. As the regulator of safety and reliability of the gas utility and transmission and distribution systems, the Public Utilities Commission (PUC) has been supportive of utility-initiated efforts to define performance levels and to improve seismic safety and reliability, and has not established seismic criteria independent of those used by the major utilities, which would benefit from the proposed type of research.

Objectives

Developemnt of an Applications Guideline for each mitigation strategy identified, which will a] be posted on the PEER website and b] disseminated in a series of PEER sponsored Technical Workshops.

Budget

2005 : 150000
2006 : 150000
Other :

Comments

Project Concept #154: Natural Gas Safety and Reliability - Integrity Management

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Description

With the passing of the recent Pipeline Integrity Management Rule for gas transmission pipelines in high consequence areas, engineers are in need of developing new tools to assist in evaluating the integrity of pipelines. Research in this topic area would focus on the development of soil corrosion models and in-situ technologies to evaluate external and internal pipeline integrity, respectively. The corrosion industry as created different methods of using electronic devices for evaluating the integrity of pipelines but they do not include efficient methods of evaluating the potential corrosivity rate of the soil on the pipeline. Another objective of this task would be to develop techniques for inserting cameras into pressurized gas transmission pipelines at specific liquid "drip" location to look for physical evidence of internal corrosion.

Benefits

Ultimately, the implementation of these research results by the utilities contributes to the goals of public safety as well as local and state economic resilience by minimizing the costs and impacts associated with utility disruptions due to pipeline failures. The results will also have initial impact in improving emergency response plans and preparations. The public interest will also benefit by having research results available for use by other infrastructure agencies, such as co-funders of this research, and the general business and residential communities potentially affected by pipeline failures.

Responsiveness to CEC Goals

There are no identified competitive benefits of this research; on the contrary, there is on-going interest in cooperative efforts among the utilities to improve pipeline performance. Research results are widely circulated within the utility setting, among appropriate state agencies, and in the scientific and engineering literature. The CEC, as a regulator and reviewer of new energy projects in California, would benefit by the availability of improved pipeline management technologies. As the regulator of safety and reliability of the gas utility and transmission and distribution systems, the Public Utilities Commission (PUC) has been supportive of utility-initiated efforts to define performance levels and to improve safety and reliability.

Objectives

Project deliverables would include a] an improved, practical method for predicting the corrosivity rate of buried steel pipelines in native soils with specific soil characteristic and b] a methodology for inserting cameras into pressurized gas transmission lines to document internal corrosion.

Budget

2005 : 215000
2006 : 215000
Other :

Comments

Project Concept #155: Detection of Gas Leaks and Pipe Boockages Using Embedded Wireless Network Sensor Systems

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Description

Highly accurate systems for detection of distribution system gas leaks have garnered considerable attention and research in an effort to improve piping integrity and environmental safety. Conventional methods, including plume detection methods, are only done periodically and as such are not real-time. An additional need is the ability to detect and locate pipe blockages and water intrusion in low-pressure systems. This project seeks to combine leak detection and blockage detection into a single monitoring system. The approach for this project is the coupling of miniature pressure/flow sensors with a wireless communication network and placing this system within the pipe system for leak and blockage detection

Benefits

The primary benefit derived from this project is a new method that enables real-time monitoring and accurate detection of gas leaks and pipe blockages. The use of this equipment would increase the safety and reliability of both new and existing natural gas distribution systems.

Responsiveness to CEC Goals

This meets the environmental criteria in that it can help prevent a possible pipeline rupture. It also offers a reasonable probablility of providing benefits to the public in preventing interuptions in gas service.

Objectives

This project will produce a sensing system capable of monitoring both leaks and blockages real-time, using one unit. It will couple pressure and flow sensors, and develop and algorithm to assist in differentiating between small operational fluctuations and acutal leaks or blockages

Budget

2005 : 150000
2006 : 200000
Other :

Comments

Project Concept #156: Reduction of Third Party Incidents Through Prevention of Mechanical Damage

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Description

According to industry statistics, third party and operator induced mechanical damage accounted for over 30% of the reported piping failure incidents in 2001. Several technologies have been developed to detect and quantify third party damage after it has occurred, including magnetic flux leakage an eddy current in-line inspections. Though valuable, these techniques are limited in that they do not provide in-situ impact detection and require system shutdown. Recent advances in commercially available wireless communication technologies and components have resulted in significant cost reductions and performance enhancements. This system would utilize active radio frequency indentification tags and the global positioning system, along with sensors installed on construction equipment, to set up a system to prevent such third party damage from occuring.

Benefits

The primary benefit derived from this project is a new method to prevent rather than just detect third party induced mechanical damage. Because third party damage is nominally considered the leading cause of pipeline incidents, application of this technology will significantly reduce the number of incidnets and thereby reduce overall operations costs, lessen environmental impacts, and enhance pipeline integrity.

Responsiveness to CEC Goals

This project fits under the enviromental criteria, in that it helps prevent damage to the natural gas pipeline system and in turn prevents any damage to the surrounding area that may result from a ruptured pipe. It also offers the benefits to the public of increased safety and improved system reliability

Objectives

The project would develop a system consising of (1) passive and active radio frequency identification tags, (2) a system of "motes" - developed by UC Berkeley. These are similar to RFID tags in that they are tiny wireless radio and semiconductor devices but are significantly more advanced in that they are run by a microcontroller that enables them to form the basic building blocks of a wireless sensor network. These are installed on the pipe, and (3) a mote reader system to be installed on the construction equipment.

Budget

2005 : 150000
2006 : 200000
Other :

Comments

Project Concept #157: Monitoring of Internal Corrosion Using Fluidized Sensors

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Description

Internal corrosion fo metal piping is a leading cause of distribution systems failures leading to product losses, destrcution of property and personnel injuries. Internal Corrosion Direct Assessment(ICDA) is a methodology that has been developed to determine likely locations of internal corrosion without the need for direct inspection using inline inspection tools (i.e. Pigs). ICDA utilizes several factors such as gas pressure, flow rate, water content, and geological incline to determine likely locations for water drop out and thus corrosion. Though ICDA does hold promise to prioritize the locations for pipeline excavation, it does not provide a direct measure if water is actually present at those locations nor does it determine if corrosion is occurring. This project is to develop a complimantary technology that can be introduced into non-pigable pipeline and distribution systems to remotely detect and monitor corrosion at locations predicted by ICDA. It will utilize miniaturized sensor packages that are introduced into the gas stream and allow remote interrogation of the internal corrosion.

Benefits

This project provides a significant complimentary advantage to the ICDA methodolgoy currently under development. The introduction of sensors to the gas stream that can be used in non-pigable lines will allow remote detection and monitoring of corrosion and the presence of water. Thus, if no water is detected even though water is predicted by ICDA, pipe excavation is not needed.

Responsiveness to CEC Goals

This falls under the environmental criteria in that it could help prevent failure of piping sustems and the possible damage to surrounding areas if a failure occurred. It also provides direct benefits to the general public in increased pipeline safety and improved system reliability.

Objectives

This project will develop and series of sensors comprised of wireless network backbone, an environmental corrosivity sensor, and a sensor to measure the corrosion rate. The senors will be encapsulated in a polymeric sheath whose surface properties can be manupulated to range from hydrophilic to hydrophobic. By doing so, the sensors can flow in the gas stream and move to the locations of water accumulation. Once in these locations, the corrosivity and corrosion rate sensors can provide information regarding the condition of the pipe. This project will develop and test such a sustem

Budget

2005 : 150000
2006 : 100000
Other :

Comments

Project Concept #158: Sterling Engine Testing Program

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Description

An ENX 25 Sterling Engine (manufactured by STM) was tested by USC with mixed results, the problem area being leakage from the hydrogen generator. This testing was concluded and a new series is proposed to test the STM Model 260 unit (55 kW). The seals used in this model are an improvement over the ENX 25 previously tested. The goal of this project will be to install the unit at USC and test the unit, including the utilization of the waste heat from the engine.

Benefits

The benefits of this project will be that it will help to bring a highly efficent and environmentally safe power generation system to the California consumer.

Responsiveness to CEC Goals

This project qualifies for Public Interest funding under increased energy efficiency.

Objectives

The key objectives will be to install the engine and test for the rate of hydrogen generation, leakage rate, noise level, emissions levels, and power ouput and total system efficiency. The waste heat will be utilized and the unit will be connected directly to the grid using the 480V outlet

Budget

2005 : 106500
2006 :
Other :

Comments

USC will provide $58,000 in cost sharing. SoCalGas participated in the first phase of this project.

Project Concept #159: Inhibiting Dynamic Combustin Instability in Gas-Fired Industrial Application

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Description

GTI has successfully conducted research that yielded a passive and generic solution for the dynamic combustion instability(DCI) (thermal acoustic instability) that has troubled the combustion industry for decades. The research concluded that the axis-switching phenomena in the flow field, generated by non-circular nozzles, promoted high vorticity fields to be in the path of the acoustic waves. A detailed acoustic study at GTI for the last several years showed that a non-circular nozzle, under longitudinal mode of DCI, consistently outperformed a round nozzle across the range of frequencies tested by 7% to 62% at the equivalence ratios tested. GTI will capitalize on the current research findings, and will develop the non-circular-nozzle technology to provide general design criteria that can be applied to all gaseous combustion applications. The emphasis in previous studies has been on single nozzle designs and laboratory-scale investigations. In industrial practices, multi-nozzle arrangements are common. However, understanding the additional complications that result from the interaction of various nozzles in this multi-nozzle environment is not only of fundamental interest, but also a critical step before successful technology deployment.

Benefits

The benefits will be lower emissions from the burner:

Control Output	CO ppm	NOx PPm
25%	1	12
50%	5	8
75%	25	6
100%	29	8

Responsiveness to CEC Goals

This project fits under the emissions criteria, offering lower emissions than are currently availble from burners in the target applications

Objectives

The proposed project will progress in the following phases: (a) study of detailed flow structures, acoustic fields for single nozzle at selected ranges of firing rates, and fuel-to-air ratios, (b) nozzle interference studies with two to six nozzles with the use of optical/laser state-of-the-art diagnostics and other non-disturbing visualization means, (c) optimization of nozzle patterns, spacing, and orientations that yields the maximum effect of DCI inhibition, (d) modification the commercial burner to prove the anticipated benefits. The work will be performed in three sections (1) a detailed flow structures and acoustic field study for single nozzles (2) nozzle interference and optiomal arrangement study, (3) in-house evaluation of a selected commercial burner, and (4) data processing and analysis

Budget

2005 : 220000
2006 : 184000
Other :

Comments

This is a submittal by SoCalGas on behalf of GTI.

Project Concept #160: Direct Assessment of Older Pipeline Systems

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Description

Older gas piplines require inspections to ensure safety of the system. The West Coast and particularly California, are unique in the potential risk from earthquakes and pipelines in landslide areas. The purpose of this project is to understand the aging process in these systems, particularly with regard to welding methods, installation procedures, and construction materials involved. The information produced from this effort will be used to analyze and establish installation, design, maintenance, and replacement criteria for California pipe systems.

Benefits

This project will provide direct benefit to California citizens in increase system reliability and increased safety in seismic events.

Responsiveness to CEC Goals

This fits under the environmental criteria in that it will help prevent pipeline failures.

Objectives

The objectives are (1) determine performance of natural gas pipe over time (2) establish performance of pipeline in earthquake conditions, (3) update requirements for pipeline maintenance proceedures

Budget

2005 : 150000
2006 : 150000
Other :

Comments

Project Concept #161: Deploying CHP wth CEMS device in the SCAQMD Basin

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Description

This project will fund the installation of a Continuous Emissions Monitoring System (CEMS) on a Solar Turbines Mercury 50 gas turbine-generator power plant located within the South Coast Air Quality Management District (SCAQMD). The primary target application for this power plant will be cogeneration or building cooling, heating and power (BCHP), with a secondary target application for utility grid support. The Mercury 50 has demonstrated <5 ppm of NOx emissions and <10 ppm of CO emissions in extensive factory testing, without the need for post-combustion cleanup systems. This project will, however, enable the first field testing of a Generation 3 Mercury 50 recuperated gas turbine on an extended basis covering a full year of variation in ambient temperature and operating conditions. The goals of the project will be to demonstrate the ability for this perform in the SCAQMD Basin at the emission standards levels of <5 ppm of NOx and <10 ppm of CO emissions over as wide as possible a range of ambient temperature and from 50% to 100% of full load conditions. Importantly, these results will also be demonstrated without the need for post-combustion cleanup systems.

Benefits

Benefits from the project will accrue to the California economy through improved energy efficiency and economic competitiveness at facilities within the SCAQMD area (and elsewhere) that can deploy the Mercury 50 in either heat recovery or power generation-only applications. As outlined in the original U.S. Department of Energy industrial Advanced Turbine Systems program objectives, the Mercury 50 was targeted to achieve at least a 15% improvement in efficiency compared with other commercially available technology, while achieving substantial reductions in NOx, CO, CO2 and UHC emissions. A number of the applications of the Mercury 50 are expected to be at locations where the electrical power and thermal energy produced by the gas turbine and its heat recovery system may enable considerable offsets of existing emissions at higher levels. Considerable economic and environmental lost opportunities could result from forgone projects caused by a requirement to place post-combustion cleanup systems on the Mercury 50. These losses could be avoided if data from this project that demonstrate reliable extended operation below 5 ppm NOx and 5 ppm CO enables projects to be sited and permitted without costly post-combustion cleanup systems.

Responsiveness to CEC Goals

This project will qualify under both energy efficiency and environmental benefits offered by the technology.

Objectives

The most important outcome of this project would be a demonstration of the environmental performance of the recuperated Mercury 50 gas turbine, successfully achieving in the field <5 ppm of NOx and <10 ppm of CO emissions over a wide range of ambient temperature and operating conditions, without the need for post-combustion cleanup systems. Analysis of the results will significantly add to the database available to support the definition of appropriate siting and permitting requirements for clean, ultra lean premix combustion, recuperated gas turbines. The results of this project will also support future operability, reliability and performance improvements in gas turbine technology.

Budget

2005 : 150000

2006 : 50000
Other :

Comments

The SCAQMD might be a possible source of co-funding for this project.

Project Concept #162: Molten Carbonate Fuel Cell Demonstration

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Description

The is a need for advanced power generation systems in California to take advantage of the high efficiencies, environmentally cleaner, and on-site technologies. The largest unit currently available is a 250 kW unit. This unit is sized well for both commercial and industrial applications. This project would puchase one of these units, install it at a site in the SDG&E service territory. The site would be at a customer facility, so that real operating conditions could be analysed.

Benefits

This would help to bring the benefits of fuel cell technologies, particularly high temperature fuel cells, to the California market.

Responsiveness to CEC Goals

This project would meet the energy efficiency and enviromental criteria.

Objectives

The fuel cell would be operated for a minumum of one year. Data collected would include (but not be limited to): installation costs, O&M costs, power output, power quality, reliability, quality and usefullness of waste heat, electrical and total system efficiency, and cell stack performance.

Budget

2005 : 1200000
2006 : 200000
Other :

Comments

Project Concept #163: Solid Oxide Fuel Cell Demonstration

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Description

Fuel cells offer many advantages over other power generation technologies. They are beginning to enter the market place but are not as yet cost effective and their performance onsite is still not well understood. The goal of this project is to purchase and install a 5 kW solid oxide fuel cell system. The unit would be installed at a facility in the Southern California Gas service territory. It would be operated for a minimum of 1 year. Solid oxide fuel cells have the highest operating temperature of the fuel cell technologies and offer the highest efficiencies.

Benefits

This would help to bring the benefits of advanced fuel cell technologies (high efficiency, quality power, low emissions, onsite power generation) to the California consumer

Responsiveness to CEC Goals

The project meets the criteria for environmental (reduced emissions) and effiency.

Objectives

The unit would be installed and operated for a minumum of 1 year. The data collected would include (but not be limited to) installation costs and methods, electrical output, power quality, system reliability, electrical and total efficiency (the unit will have waste heat suitable for a CHP application), stack life, overall system performance, and availablility.

Budget

2005 : 350000
2006 : 50000
Other :

Comments

Project Concept #164: Particle Production from Natural Gas Combustion

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Description

Particle Production from Natural Gas Combustion

Nancy Brown

Most practical combustion systems have turbulent flow fields and operate at pressures far in excess of ambient. There is a class of combustion devices that operate in the laminar flow regime and at ambient pressures. Examples of this type of combustor are found in residential gas stoves and other small scale gas-fired home appliances. They most frequently burn natural gas, and particle formation from their combustion has been reported to be particularly onerous. Hildemann et al. (1991, 1994) and Rogge et al. (1993) found that natural gas appliances emitted 0.0389 μg OC/kg fuel where OC is the "organic" carbon in the emitted particles. Hannigan et al. (1994, 1997) report that

"Even though the OC emission rate from natural gas appliances is more than an order of magnitude smaller than from oil fired boilers, the mutagenicity per unit mass of fuel burned is nearly an order of magnitude greater than for a fuel oil-fired burner."

Solvent extraction followed by chemical analysis revealed that the mutagenicity was most likely attributable to aromatic compounds that are polycyclic heteronuclear organic compounds containing nitro functional groups.

The combustion in these more practical systems is partially premixed whereby one has a first stage premixed flame followed by a second stage diffusion flame. It is important to determine:

1) which stage contributes the particles of greater organic content (relative to elemental or black carbon),

2) which stage emits particles containing the types of compounds observed by Hannigan et al.

3) the identification of the organic compounds in the particles, and

4) whether these compounds are located on the particle surface.

Answering the first two questions is important because if the more toxic compounds were produced in the second stage, these simple combustion systems could be redesigned to run entirely in the premixed mode. Answering the third question is important for designing potential mitigation approaches. Answering the fourth question is important for addressing issues of bioavailability because the compounds indicated by Hannigan et al. all appear to be polar, suggesting potential water solubility.

It is important to design well-controlled laboratory scale experiments to answer these questions , and to characterize the particles.

Benefits

Natural gas combustion results in less CO2 than coal or oil because of its large H/C ratio. This makes it the fuel of choice for reducing climate impacts associated with fossil fuel combustion. It also is considered a clean fuel with respect to many criteria pollutants like SO2. Natural gas also contains no fuel-bound nitrogen or sulfur; hence emissions of SO2 and NOx and other nitrogenous compounds tend to be less than for fuels with higher nitrogen and sulfur content. It is, however, important to characterize gas phase and particle emissions from natural gas because these tend to be ozone precursors, particle precursors, or particles that can have significant toxicity. It is important to identify combustion conditions that optimize the reduction of these health threatening emissions to protect public health.

Responsiveness to CEC Goals

This project is concerned with environmental issues associated with natural gas combustion.

Objectives

The objectives of the research would be to answer the following questions:

1) which stage contributes the particles of greater organic content (relative to elemental or black carbon),

2) which stage emits particles containing the types of compounds observed by Hannigan et al.

3) the identification of the organic compounds in the particles, and

4) whether these compounds are located on the particle surface.

An important outcome of this research will be to identify potential health hazards of natural gas combustion, but more importantly it will identify combustion conditions that minimize the hazards. By characterizing the aerosol properties as a function of combustion conditions, conditions that led to poor aerosol production and limited aerosol bioavailability could be identified.

Budget

2005 : $400 K
2006 : 0
Other : $400K

Comments

Some of the proposed research would be conducted at the LBNL Advanced Light Source

Project Concept #165: Transport Properties for Modeling Natural Gas Combustion

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Description

Combustion models are valuable resources for designing and optimizing natural gas combustion conditions so that the energy efficiency can be optimized and pollutant emissions can be minimized. Models are only as good as their input parameters and the robustness of the algorithms used to compute the characteristics of the combustion process. Important input parameters tend to be molecular transport parameters and chemical kinetic rate parameters. A sensitivity analysis has revealed that transport properties are as important in flame modeling as influential reaction rates, and both should be taken into account when building chemical mechanisms. Transport parameter importance was found to vary according to the independent variable being considered and the flame type. The molecular parameters that underlie the transport properties are found to be particularly important. The present state of affairs is that many of the transport properties currently used to model natural gas combustion have large uncertainties and errors. The uncertainties in transport propagate through the combustion models and seriously compromise the results.

Benefits

Models will be used to design combustors and to identify combustion conditions that optimize the trade-off between energy efficiency and emissions reductions. This is important for air quality and global climate, and is important for human health and the state's economic well-being. This research will results in the development of more accurate models which should speed up the design process and result in the new production of environmentally benign combustion systems.

Responsiveness to CEC Goals

This project is concerned with environmental issues associated with natural gas combustion.

Objectives

We propose research to improve the transport properties of species associated with natural gas combustion. As the combustion becomes more dependent on transport, that is, as one moves from premixed laminar flames to turbulent diffusion flames the role of transport becomes even more important. We propose to provide improved descriptions of species molecular diffusion, viscosity, and thermal conductivity by improving collision integral representation and the underlying molecular parameters. We also propose to identify the mixture approximation that appropriately satisfies the competing demands between accuracy and computational efficiency for different types of combustion modeling.

Budget

2005 : $ 300 K
2006 : 0
Other : $ 300 K

Comments

Project Concept #166: Increasing the Efficiency of Microturbines by Enhanced Ceramics

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Description

Today's microturbines are becoming an important part of the distributed generation marketplace. They operate at efficiencies of 22-27%. By increasing operating temperatures from 1600F to over 2000F, the efficiencies can increase to 30-35%. However, this places substantial stress on the hot section components. Therefore, in order to tolerate the higher operating temperatures the use of ceramic components and advanced alloys are required.

Benefits

The operating efficiencies of the microturbines could increase by 25-50% thereby giving the customers and ratepayers operating savings, reducing fuel consumption and making the overall system more reliable and durable.

Responsiveness to CEC Goals

This project fits under the environmental and efficiency criteria.

Objectives

Ceramics materials will be investigated for durability and performance characteristics in the compressor wheels, turbine wheels, combusters, and housings that will be exposed to high temperatures. The result of this work will allow manufacturers to apply these new ceramic components to the microturbine.

Budget

2005 : 1000000
2006 : 1000000
Other : 2000000

Comments

Project Concept #167: Alternative Gas Supplies

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Description

To meet anticipated increases in natural gas demand in the State of California, alternative sources of natural gas are expected to supplement traditional North American supplies to maintain a reasonable near-term supply/demand balance and to keep gas commodity prices in an acceptable range. This will necessitate new gas production from unconventional domestic resources (e.g., tight sands, gas shales and coalbed methane), and from increased imports of liquefied natural gas (LNG).

Improved societal and technical understanding is necessary concerning the degree to which gas from unconventional sources and LNG from various international sources can supplement traditional North American natural gas without hindering the safe, efficient, and environmentally acceptable delivery and use, while addressing public concerns and local impacts. Efforts are necessary to investigate issues associated with siting and operating LNG receiving terminals and processing facilities, while minimizing impacts on the gas delivery infrastructure that will deliver the gas to the end user. It will also be important to ensure that natural gas from a whatever source can be mixed or interchanged for interconnection at utility delivery points to assure consistent quality that will minimize any adverse impacts on end user equipment operation or durability.

Close coordination with national efforts is necessary to minimize duplication of efforts with industry (e.g. Gas Technology Institute, American Gas Association, etc.) and Federal agency (e.g. Department of Energy) initiatives to assure the viability of a long-term natural gas supply from emerging sources..

Benefits

Through the availability of better information through collaborative efforts, California and the gas industry will be able to make sound decisions for providing adequate gas supplies, based on the merits and limitations of various options.

The primary benefit to gas ratepayers accrues through the cost savings form the existence of a larger and more economically viable gas supply resources, and enable a more diverse and reliable gas supply. Gas supply research should be designed to extend and increase the availability of economically available alternative supplies of natural gas to assure that gas quality is in line with current supplies that will minimize or eliminate gas processing by utilities to readily accept alternative sources without costly efforts, and to minimize impacts on gas customer equipment compatibility with their use, and costs to accommodate the use of alternative supplies. This will better ensure that the natural gas delivered to customers continues to be of high quality and gas from a whatever source (e.g., ultra-deep wells, unconventional formations, LNG, gasification) can be mixed or interchanged without adverse impact on equipment operation or durability..

Responsiveness to CEC Goals

PG&E is not adequately funded to investigate natural gas supply issues upstream of utility gas supply delivery points that are different from traditional sources. Efforts are underway on a national level to investigate issues and pursue research to investigate emerging natural gas supplies, but not looking at issues that may specifically relate to the State of California.

This program will directly address the goal of the State of California Energy Action Plan to “ensure a reliable supply of reasonably priced natural gas”, and to “maximize a common understanding and ensure a broad basis for decision making”. In addition, it should seek opportunities for collaboration and co-funding opportunities with other entities so to avoid duplication of effort by others..

Objectives

A program should investigate, identify and address issues related to unconventional gas supplies and LNG sources to assure a timely and cost-effective contribution to the California gas supply. Collaboration with other agencies is necessary to minimize duplication of efforts, understand overall issues associated with alternative natural gas supplies, understand regional issues specific to California, definition of gaps that are specific to California, and investigation of alternatives to address those issues. Standards of gas quality (e.g. AGA 36) from multiple diverse suppliers should be clearly defined to assure that natural gas supplies are provided at utility delivery points that is of acceptable quality to address interchangeability issues associated with possible variations between the quality of re-gasified imported LNG and unconventional sources that could affect the delivery infrastructure or end-use equipment.

Budget

2005 : 100,000
2006 : 200,000
Other : 200,000

Comments

Project Concept #168: Characterizing the Energy Efficiency Potential of Gas-fired Commercial Food Service Equipment

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Description

The California Restaurant Association (CRA) reports 77,940 commercial food service establishments in California. However, this inventory of commercial food service operations neglects a large portion of the institutional segment including health care, correctional and military facilities. The National Restaurant Association (NRA) lists 870,000 food service facilities (including school and work cafeterias) in the U.S. Prorating this inventory based on population, 12% or 104,000 food service (commercial and institutional) facilities would be operating in California.

Currently, no published data exists on the installed inventory of gas-fired commercial cooking appliances in the state of California.

The scope of this study would focus on:

(1) Establishing appliance inventories for both institutional and non-institutional food service establishments. To help characterize the current market place, a review of updated information sources would include, although not be limited to, the 1989 NAFEM Equipment and Supplies Survey, the 2003 NAFEM Foodservice Equipment Study, Recount /CREST database for foodservice, and Foodservice Equipment Reports buying trend projections for North America.

(2) Once established, the inventories would provide the means for evaluating the energy-saving potential of replacing standard appliances with available EnergyStar models..

Benefits

Food service operations are the most energy intensive sub-category of the commercial sector, consuming an average 550,000 Btu/ft_ per year, but commercial cooking equipment typically exhibits low energy performance. This deficit of energy efficiency within the food service industry is due to several factors including the need to keep initial capital costs as low as possible, the historically small percentage of total operating cost represented by energy, and the lack of knowledge regarding energy efficiency within the industry. The result is that the food service industry has fallen behind other industries in energy efficiency.

A study published by the U.S. Department of Energy, “Characterization of Commercial Building Appliances,” estimates that energy efficient appliance and control systems could reduce overall food service appliance energy consumption by as much as 28 percent. Unlike food service buildings, which are governed by the Title 24 Energy Code, the energy consumption of commercial cooking appliances is presently not regulated in California. This means that the projected national savings would also apply to the State.

The potential introduction of the EPA’s Energy Star brand into the commercial food service industry presents a golden opportunity to improve the energy efficiency of food service operations. Improving the energy efficiency of commercial gas food service equipment in California could save an estimated 100 million therms per year, with an associated carbon reduction of 144,000 metric tons.

Coordination and active cooperation between the FSTC and the Energy Star program have resulted in the introduction of voluntary Energy Star standards for commercial reach-in refrigerators (2001) and for three new commercial food service equipment categories (fryers, steamers and holding cabinets, 2003). Based on the initial success of these categories, it has been recommended that Energy Star include other

categories of cooking equipment, such as ovens, in future programs. A fully matured market could demonstrate substaitially greater energy savings..

Responsiveness to CEC Goals

This R&D project concept meets the definition of public interest in the following ways:

- It will advance energy efficiency science and technology by identifying inefficient energy using appliances.
- It will benefit California citizens by reducing the amount of natural gas utilized in California – freeing up resources and potentially reducing the cost to operate.
- This research is not adequately addressed by competitive or regulated entities because there are currently no entities with qualifications and missions focusing on this R&D area.
- This R&D project concept focuses on a key, unmet area of energy efficiency science and technology, because fuel efficiency of commercial gas cooking equipment has not been adequately addressed in California.

This R&D project concept offers high probability of providing benefits to the general public because it supports State Energy policy as outlined in the California Energy Action Plan, by helping to meet California's energy growth needs while optimizing energy conservation and resource efficiency and reducing per capita gas consumption by 100 million therms. This helps to ensure a reliable supply of reasonably priced natural gas. Also, this benchmark data will provide support for future utility-based incentives for more efficient equipment.

In addition to the proposers, Pacific Gas and Electric Company and the Food Service Technology Center, additional potential collaborators and co-funders for the R&D project concept include Southern California Gas Company and San Diego Gas and Electric Company.

Objectives

The primary objective of this PIER research would be to develop inventories of commercial cooking equipment, quantifying gas load and energy efficiency potential. From the utility perspective, it would identify specific needs for incentives. From an R&D perspective, the scope of work would identify potential improvements in appliance energy efficiency and be a catalyst for product development.

Budget

2005 : 100,000
2006 : 100,000
Other : 0

Comments

Project Concept #169: Energy Efficiency Potential of Gas-Fired Commercial Hot Water Heating Equipment and Systems

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Description

Domestic hot water (DHW) heating systems in small commercial installations, particularly load intensive facilities such as commercial food service, represent a significant gas load in California. In full service and institutional kitchens with dishwashing operations, the hot water heating load can represent up to 10% of the total energy bill and up to 30% of the total gas load for the facility. But despite the large gas load associated with this end use, there has been very little initiative to develop high-efficiency water heating equipment and systems for this building sector (particularly when compared with the residential or large commercial/industrial market).

The FSTC has monitored DHW systems, documenting system efficiencies (where re-circulation loops are in operation) of less than 50%. Although instantaneous water heaters may be touted as the solution, there are no documented case studies confirming energy saving potential and/or end-user satisfaction. Furthermore, there is a dramatic range in product cost (and assumed reliability), from a low of $300 to a high of $3000. Independent application and design guidelines for such equipment are non-existent.

The objective of the research project would be to estimate the energy consumption of DHW systems in commercial buildings and characterize the energy efficiency potential through both equipment development and system design. The scope of work would extend to a field study designed to confirm energy savings associated with instantaneous water heating systems.

Benefits

The proposed work would directly advance the science and provide the analytical tools needed to achieve improvements in the energy efficiency of commercial DHW equipment. This project would be the first step towards obtaining more reliable, cost effective energy efficient equipment by identifying available technologies and presenting hard data regarding product performance.

A reduction in water heating equipment loads will improve energy efficiency in restaurants and lower natural gas demands. An added benefit is that it not only affects new construction, but frequently can be utilized in the retrofit applications. This is important since about two-thirds of all new restaurant openings occur in facilities that are renovated.

The California Restaurant Association (CRA) reports 77,940 commercial food service establishments in California. However, this inventory of neglects a large portion of the institutional segment including health care, correctional and military facilities. The National Restaurant Association (NRA) lists 870,000 food service facilities (including school and work cafeterias) in the U.S. Prorating this inventory based on population, 12% or 104,000 food service (commercial and institutional) facilities would be operating in California.

Currently, no published data exists on the total installed inventory of gas-fired DHW in the state of California, but using food service applications as an example of the installed base is a means of estimating the overall potential for the small commercial sector.

Based on available test data and current estimates of the efficiency of DHW systems in food service applications, increases in heater efficiency and system design could yield gas energy savings of 50 million therms annually with an associated carbon reduction of 72,000 metric tons.

Responsiveness to CEC Goals

This R&D project concept meets the definition of public interest in the following ways:

- It will advance energy efficiency science and technology by identifying inefficient energy using systems.
- It will benefit California citizens by reducing the amount of natural gas utilized in California – freeing up resources and potentially reducing the cost to operate.
- This research is not adequately addressed by competitive or regulated entities because there are currently no entities with qualifications and missions focusing on this R&D area.
- This R&D project concept focuses on a key, unmet area of energy efficiency science and technology, because fuel efficiency of commercial gas water heaters has not been adequately addressed in California.

This R&D project concept offers high probability of providing benefits to the general public because it supports State Energy policy as outlined in the California Energy Action Plan, by helping to meet California's energy growth needs while optimizing energy conservation and resource efficiency and reducing per capita gas consumption by 50 million therms. This helps to ensure a reliable supply of reasonably priced natural gas. Also, this benchmark data will provide support for future utility-based incentives for more efficient equipment.

In addition to the proposers, Pacific Gas and Electric Company and the Food Service Technology Center, additional potential collaborators and co-funders for the R&D project concept include Southern California Gas Company and San Diego Gas and Electric Company.

Objectives

The primary objective of this PIER research would be to characterize the inventories and associated energy consumption of DHW systems in both commercial restaurants and other small/low-rise commercial applications including small hospitality and laundry applications and document the energy savings potential of instantaneous water heating systems.

Budget

2005 : 150,000
2006 : 150,000
Other : 0

Comments

Project Concept #170: Characterizing the Energy Efficiency Potential of Gas-fired Commercial Food Service Equipment

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Description

The California Restaurant Association (CRA) reports 77,940 commercial food service establishments in California. However, this inventory of commercial food service operations neglects a large portion of the institutional segment including health care, correctional and military facilities. The National Restaurant Association (NRA) lists 870,000 food service facilities (including school and work cafeterias) in the U.S. Prorating this inventory based on population, 12% or 104,000 food service (commercial and institutional) facilities would be operating in California.

Currently, no published data exists on the installed inventory of gas-fired commercial cooking appliances in the state of California.

The scope of this study would focus on:

(1) Establishing appliance inventories for both institutional and non-institutional food service establishments. To help characterize the current market place, a review of updated information sources would include, although not be limited to, the 1989 NAFEM Equipment and Supplies Survey, the 2003 NAFEM Foodservice Equipment Study, Recount /CREST database for foodservice, and Foodservice Equipment Reports buying trend projections for North America.

(2) Once established, the inventories would provide the means for evaluating the energy-saving potential of replacing standard appliances with available EnergyStar models..

Benefits

Food service operations are the most energy intensive sub-category of the commercial sector, consuming an average 550,000 Btu/ft_ per year, but commercial cooking equipment typically exhibits low energy performance. This deficit of energy efficiency within the food service industry is due to several factors including the need to keep initial capital costs as low as possible, the historically small percentage of total operating cost represented by energy, and the lack of knowledge regarding energy efficiency within the industry. The result is that the food service industry has fallen behind other industries in energy efficiency.

A study published by the U.S. Department of Energy, “Characterization of Commercial Building Appliances,” estimates that energy efficient appliance and control systems could reduce overall food service appliance energy consumption by as much as 28 percent. Unlike food service buildings, which are governed by the Title 24 Energy Code, the energy consumption of commercial cooking appliances is presently not regulated in California. This means that the projected national savings would also apply to the State.

The potential introduction of the EPA’s Energy Star brand into the commercial food service industry presents a golden opportunity to improve the energy efficiency of food service operations. Improving the energy efficiency of commercial gas food service equipment in California could save an estimated 100 million therms per year, with an associated carbon reduction of 144,000 metric tons.

Coordination and active cooperation between the FSTC and the Energy Star program have resulted in the introduction of voluntary Energy Star standards for commercial reach-in refrigerators (2001) and for three new commercial food service equipment categories (fryers, steamers and holding cabinets, 2003). Based on the initial success of these categories, it has been recommended that Energy Star include other

categories of cooking equipment, such as ovens, in future programs. A fully matured market could demonstrate substaitially greater energy savings.

Responsiveness to CEC Goals

This R&D project concept meets the definition of public interest in the following ways:

- It will advance energy efficiency science and technology by identifying inefficient energy using appliances.
- It will benefit California citizens by reducing the amount of natural gas utilized in California – freeing up resources and potentially reducing the cost to operate.
- This research is not adequately addressed by competitive or regulated entities because there are currently no entities with qualifications and missions focusing on this R&D area.
- This R&D project concept focuses on a key, unmet area of energy efficiency science and technology, because fuel efficiency of commercial gas cooking equipment has not been adequately addressed in California.

This R&D project concept offers high probability of providing benefits to the general public because it supports State Energy policy as outlined in the California Energy Action Plan, by helping to meet California's energy growth needs while optimizing energy conservation and resource efficiency and reducing per capita gas consumption by 100 million therms. This helps to ensure a reliable supply of reasonably priced natural gas. Also, this benchmark data will provide support for future utility-based incentives for more efficient equipment.

In addition to the proposers, Pacific Gas and Electric Company and the Food Service Technology Center, additional potential collaborators and co-funders for the R&D project concept include Southern California Gas Company and San Diego Gas and Electric Company.

Objectives

The primary objective of this PIER research would be to develop inventories of commercial cooking equipment, quantifying gas load and energy efficiency potential. From the utility perspective, it would identify specific needs for incentives. From an R&D perspective, the scope of work would identify potential improvements in appliance energy efficiency and be a catalyst for product development.

Budget

2005 : 100,000
2006 : 100,000
Other : 0

Comments

Project Concept #171: Energy Efficiency Potential of Gas-Fired Rooftop HVAC Units and Makeup Air Heating Systems

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Description

Packaged rooftop HVAC units dominate in the low-rise commercial building sector; particularly sub sectors such as restaurants and retail stores in California. Initiatives to increase the energy efficiency of packaged rooftop equipment have been focused on the cooling side, dictated by the U.S. market and needs. However, there is very little effort, if any, being directed towards raising the nominal 78% annual fuel utilization efficiency (AFUE) claimed by most manufacturers. As a contrast, condensing furnaces have become a standard energy efficiency option in the residential market. Although there have been reported initiatives in the past to introduce high-efficiency condensing furnaces or direct-fired heaters within packaged rooftop units, commercialization has not been realized. A major end-user "pull" coupled with a codes and standards "push" is needed to transform this market. Both product and product application knowledge need to be developed.

A subcategory of the packaged rooftop HVAC unit is the 100% outdoor (makeup) air unit. Fortunately, the outdoor (makeup) air heating load in California climate zones drops off dramatically as the set point temperature of the air supplied to the space is reduced. In fact, if makeup air can be strategically introduced by capitalizing on internal heat gains from equipment, the heat load can become negligible. Unfortunately, there are many instances where makeup air heating systems in commercial facilities are controlled by a duct stat that is either preset at the factory or set by the installer at temperatures of 65°F or higher. The energy penalty associated with this arbitrary control strategy is dramatic and can result in a space that is mechanically heated and cooled at the same time.

This project will characterize the installed base of packaged rooftop equipment on low-rise commercial buildings and quantify the potential energy savings with the pplication of more efficient units and control strategies.

Benefits

The proposed work will directly advance the science and provide analytical tools needed to achieve improvements in the energy efficiency of commercial rooftop HVAC equipment. More specifically, this project will be the first step towards obtaining more reliable, cost effective energy efficient equipment by identifying available technologies and presenting hard data regarding product performance.

A reduction in packaged rooftop equipment loads will improve energy efficiency in small commercial applications, lower natural gas demands, and potentially reduce capital construction costs by decreasing the size of installed HVAC equipment. An added benefit of this work is that it not only affects new construction, but frequently can be utilized in the retrofit applications. This is an important benefit since, for instance, about two-thirds of all new restaurant openings occur in facilities that are renovated.

Based on preliminary estimates of the number of packaged roof top and makeup air units in California, potential annual energy savings would be in the range of 150 million therms with an associated reduction in carbon emissions of 216,000 metric tons..

Coordination and active cooperation between the FSTC and the Energy Star program have resulted in the introduction of voluntary Energy Star standards for commercial reach-in refrigerators (2001) and for three new commercial food service equipment categories (fryers, steamers and holding cabinets, 2003). Based on the initial success of these categories, it has been recommended that Energy Star include other categories of cooking equipment, such as ovens, in future programs. A fully matured market could demonstrate substaitially greater energy savings.

Responsiveness to CEC Goals

This R&D project concept meets the definition of public interest in the following ways:

- It will advance energy efficiency science and technology by identifying inefficient energy using systems.
- It will benefit California citizens by reducing the amount of natural gas utilized in California – freeing up resources and potentially reducing the cost to operate.
- This research is not adequately addressed by competitive or regulated entities because there are currently no entities with qualifications and missions focusing on this R&D area.
- This R&D project concept focuses on a key, unmet area of energy efficiency science and technology, because fuel efficiency of commercial gas heaters has not been adequately addressed in California.

This R&D project concept offers high probability of providing benefits to the general public because it supports State Energy policy as outlined in the California Energy Action Plan, by helping to meet California's energy growth needs while optimizing energy conservation and resource efficiency and reducing per capita gas consumption by 150 million therms. This helps to ensure a reliable supply of reasonably priced natural gas. Also, this benchmark data will provide support for future utility-based incentives for more efficient equipment.

Objectives

The primary objective of this PIER research would be to develop inventories of commercial cooking equipment, quantifying gas load and energy efficiency potential. From the utility perspective, it would identify specific needs for incentives. From an R&D perspective, the scope of work would identify potential improvements in appliance energy efficiency and be a catalyst for product development.

Budget

2005 : 175,000
2006 : 175,000
Other : 0

Comments

Project Concept #172: Energy Efficient Ultra Low NOx Industrial Burner

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Description

Steam generation is a vital part of most all industries, whether it is steam for heating and cooling needs, or high pressure steam to operate key processes. Industrial steam is generated in boilers that are strictly regulated by the state and local air resource boards. Nitrogen oxides (NOx) in particular are a species of pollutants that are closely monitored and controlled. Low NOx burners are the primary means of controlling NOx emissions for industrial boilers. Current Low NOx burner technology relies on the recirculation of boiler flue gases into the burner combustion air to alter the burner flame combustion profile. This enables the boiler to meet the state's strictest ultra low NOx emission standards, but it does have an efficiency penalty. The mass flow of the recirculated flue gas must be conveyed and pressurized, resulting in significantly higher fan horsepower requirements and energy consumption.

Advanced developments in ultra low NOx burner design would eliminate the need for flue gas recirculation (FGR) and afford significant energy savings, as well as significant financial savings for industry. Since natural gas is the primary industrial fuel in California, specific development in low NOx gas burners would be most appropriate.

Benefits

The potential energy savings for the state exceed 30 MW. This estimate is based upon the number of industrial boilers in the state, the average combustion air and FGR flow rates, and the average combustion air supply static pressure. These energy savings are directly related to decreases in fan horsepower requirements. Additional industry benefits would result from physically smaller burners and boilers, which can be utilized due to the reduction in system mass flow. This would include reduced capital costs, reduced installation costs, and reduced maintenance costs. The burner / boiler assembly would also occupy a smaller footprint, offering additional facility management benefits.

Responsiveness to CEC Goals

This R&D project concept meets the definition of public interest in the following ways:

- It will advance energy efficiency science and technology by creating a new alternative to inefficient industrial burners.
- It will benefit California citizens by reducing energy consumption by the highest energy users – freeing up resources and reducing costs for industry to operate.
- This research is not adequately addressed by competitive or regulated entities because there are currently no entities with qualifications and missions focusing on this R&D area.

This R&D project concept focuses on a key, unmet area of energy efficiency science and technology, because fuel efficiency industrial burners has not been adequately addressed in California.

This R&D project concept offers high probability of providing benefits to the general public because it supports State Energy policy as outlined in the California Energy Action Plan, by helping to meet California's energy growth needs while optimizing energy conservation and resource efficiency and reducing industrial gas consumption and emissions. This helps to ensure a reliable supply of reasonably priced natural gas. This R&D project concept would also address the lack of energy efficiency incentives

placed on industrial users by the Air Resource Board. While existing air emission requirements are very efficient at reducing ambient air pollution levels, they do not encourage high energy efficiency.

Objectives

An R&D project concept would include the design, production, and testing of an ultra low NOx burner prototype that meets all California air emission standards for a natural gas fired industrial boiler, while requiring no FGR. Additionally, the prototype burner would not require an increase in current standards for combustion air supply static pressure, and would not require an increase in current standards for total excess combustion air mass flow. The project could culminate in the successful installation and commissioning of beta unit at an industrial host facility, possibly in conjunction with the Statewide IOU Emerging Technologies Program. The estimated time frame for such a project would be two years. The new technology could then be sold or licensed to provide access to the market.

Budget

2005 : 525,000
2006 : 525,000
Other : 0

Comments

In addition to the proposers, Coen and Pacific Gas and Electric Company, additional potential collaborators and co-funders for the R&D project concept include Southern California Gas Company and San Diego Gas and Electric Company, along with industry affiliate research organizations and user groups.